Statistical Analysis and Areal Trends of Background Concentrations of Metals in Soils of Clark County, Washington

By Kenneth C. Ames and Daniel B. Hawkins

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 96-4252

Prepared in cooperation with
WASHINGTON STATE DEPARTMENT OF ECOLOGY

Tacoma, Washington
1997

U.S. DEPARTMENT OF THE INTERIOR

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CONTENTS

FIGURES

TABLES

TABLES--Continued

CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
acre	0.4047	hectare

Sea Level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)-- a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

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ABSTRACT

Seventy-nine soil samples, collected from 26 sites in Clark County, Washington, were analyzed to determine background concentrations of metals in the soils. This study, done in cooperation with the Washington State Department of Ecology, was conducted because background data were needed as a reference to determine if, and to what degree, soils were contaminated at sites within Clark County where contamination was suspected. The 79 samples were collected randomly from 11 different soil taxonomic series in areas of Clark County that were relatively undisturbed by human activity.

Concentrations of 40 metals were determined for 53 samples by the total method. Concentrations of 17 metals were determined for all 79 samples by the total-recoverable method and for 29 samples by the American Society of Testing and Materials leaching method and by the Toxicity Characteristic Leaching Procedure. The metals included 13 inorganic priority pollutants listed by the Environmental Protection Agency. Cation exchange capacity, soil-solution pH, electrical conductance, organic carbon content, particle-size distribution, and concentrations of total petroleum hydrocarbons and polychlorinated biphenyls also were determined.

The arithmetic means of total metals concentrations in soils within Clark County were considerably different from the arithmetic means of total metals concentrations in soils of the conterminous United States reported by other investigators. For example, arithmetic mean concentrations of total arsenic, chromium, copper, nickel, vanadium, and zinc in Clark County were 10, 60, 37, 24, 179, and 112 milligrams per kilogram, respectively, compared to mean concentrations of 5.2, 37, 17, 13, 58, and 48 milligrams per kilogram for the conterminous United States.

Concentrations of metals determined by the total-recoverable method varied considerably within Clark County. However, areal trends in the data demonstrated that the variability was related to the geology of the county. Concentrations of metals determined by the total method also varied within Clark County, but this observation was based on a limited number of samples. A principal components analysis showed that five factors accounted for 72.8 percent of the total metals concentrations variance and five different factors accounted for 78.8 percent of the total-recoverable metals concentrations variance. Multiple discriminant analysis showed that the total-recoverable metals concentrations data could be partitioned into five different groups. Sample variance was minimized by partitioning the total-recoverable metals concentrations data into these different groups, and, as a result, the number of samples collected were determined to be adequate to characterize baseline total-recoverable concentrations of most metals.

Individual sources of variance were determined to estimate the contribution of different sources to sample variance, including soil series and sampling depth. A one-way analysis of variance showed that total and total-recoverable concentrations of some metals were significantly different between different soil series. Similarly, results from a Wilcoxon Rank Sum test showed that total and total-recoverable concentrations of some metals also were significantly different at different depths within a soil

profile. As a result, it may be necessary to consider such differences when background concentrations of specific metals in soils of Clark County are being characterized.

Numerous significant correlations existed among metals concentrations, and many metals were placed into one of four groups based on the significance of their correlations with concentrations of organic carbon, particle size distribution, and cation exchange capacity.

INTRODUCTION

In 1987 the U.S. Geological Survey (USGS), in cooperation with the Washington State Department of Ecology (Ecology), began a series of studies to obtain data on the magnitude and variability of background concentrations of metals in soils. This information was needed for different areas of Washington State because the existing data were not adequate to determine if soils at potentially contaminated sites were, in fact, contaminated.

Background

The first study was conducted on parts of the Big Soos Creek and Little Soos Creek drainage basins in southwestern King County. Soil samples were collected from various locations within the basins at depths up to 5 feet and were analyzed at various laboratories to determine concentrations of as many as 44 elements, in addition to other chemical and physical characteristics (Prych and others, 1995). (Although some of the elements of interest are not metals, for convenience, all elements will be referred to as metals throughout this report.) Streambed sediments samples were also collected from two locations on Big Soos Creek and from one location on Little Soos Creek. A second study, conducted in 1990, was a statewide reconnaissance in which soil samples were collected from 60 locations and analyzed for concentrations of as many as 43 metals (Ames and Prych, 1995). Unlike the Soos Creek study, samples were collected at a single depth, and no streambed sediments were collected. Since the initiation of these studies, additional areas of interest have been identified (Ames, 1994; San Juan, 1994; San Juan and Ames, 1994), one of which was Clark County.

Other investigators have conducted similar studies to determine metals concentrations in surficial materials and soils collected from relatively undisturbed and uncontaminated areas at various locations within the United States. These include a study done by Shacklette and Boerngen (1984) of the conterminous United States and a study done by Gough and others (1988) of the State of Alaska, both of which described regional geochemical trends. Other studies, including those by Gough and others (1985), Severson (1977), Severson (1978), and Severson and Wilson (1990), focused more heavily on establishing baseline concentrations of metals in soils.

Purpose and Scope

This report presents data on the magnitude and variability of background concentrations of metals in soils in Clark County. This information was used to (1) compare the results of the different laboratory methods used; (2) characterize individual sources of variance (for example, the variability of metals concentrations in soils as a function of depth); (3) examine the relations among different metals and between metals concentrations and other soil properties (for example, the content of copper versus the content of organic carbon in the soil); and (4) determine if different soil types, soil associations, or some other grouping of samples were characterized by particular assemblages of metals.

This report presents, in tabular form, all the data collected in this study. Summary statistics for all the metals are presented, the sources of variance of the different metals are discussed, and the matrices of correlation coefficients between the various metals and other soil characteristics measured are given. Results from principal components analysis and multiple discriminate analysis also are given.

Acknowledgments

The authors express their appreciation to Edmund Prych of the USGS for his assistance and input toward the collection and interpretation of the data in this report. The authors also recognize the technical reviews made to this report by Charles Severson and Roger Fujii of the USGS, and the editorial review by James Lyles of the USGS. Noah Matson of the USGS prepared much of the illustrations and Virginia Renslow of the USGS prepared the manuscript.

STUDY AREA

This study was conducted in Clark County, in southwestern Washington (fig. 1). The Columbia River borders Clark County on the south and west, the Lewis River borders it on the north, and the foothills of the Cascade Range lie to the east of the county. The locations of individual collection sites and physical descriptions of the soils at each site are given in table 1.

Geologic Setting

Clark County lies between the Cascade Range to the east and the Coast Range to the west and is composed of a series of terraces with step-like benches oriented northwest-southeast (Mundorff, 1964). Eocene to Miocene consolidated volcanic rocks are interfingered with various alluvial and volcanic sediments, exposed in eastern Clark County (Trimble, 1963; Mundorff, 1964). These consolidated volcanic rocks generally underlie younger unconsolidated alluvial sediments exposed in the west (fig. 2). Mundorff (1964) divided the various terraces into four physiographic areas: (1) the Foothills, (2) the Troutdale Bench, (3) Fourth Plains and Terraces, and (4) the Lowland Valley Area (fig. 3).

The Foothills area is located in the northeastern one-third of Clark County and consists of older consolidated volcanic rocks that are primarily andesitic rocks of the Skamania series and rocks from the Goble volcanics series that are composed of basalts interfingered with Cowlitz Formation marine sediments. Other miscellaneous volcanic and volcanoclastic rocks, such as Eagle Creek vitric tuffs, also are exposed at some locations along with various intrusive rocks (Mundorff, 1964).

The Troutdale Bench is located immediately to the west of the Foothills area and is oriented in a northwest to southeast direction, extending in Clark County from the Lewis River in the north to the Columbia River in the south. The Troutdale Bench is composed mainly of the Troutdale Formation, which consists of an upper member of coarse cemented gravels or semiconsolidated conglomerates, overlying a fine-grained lower member. Outcrops of the Troutdale Formation most commonly consist of the coarse sediments of the upper member, which were primarily derived from the consolidated volcanic rocks to the immediate east (Mundorff, 1964; Phillips, 1987). However, erratics and other materials foreign to the area are intermixed with the volcanic sediments at some locations. Intrusions of vesicular basalts (Boring lavas) also are found within the Troutdale Bench.

The Fourth Plains and Terraces are a series of broad plains that lie to the immediate west of the Troutdale Bench. Consisting of late Pleistocene granitic alluvium, these sediments probably were derived from northern Idaho and northeastern Washington and transported by numerous catastrophic floods originating at glacial Lake Missoula (Trimble, 1963). As a result, the chemistry of these sediments may be different from that of sediments and rocks found in the eastern half of Clark County.

The Fourth Plains and Terraces area can be divided into two types of deposits. One, composed of finer deltaic sands, silts, and clays, is located in the northern half of the study area. The other, composed of coarser deltaic sediments, is located to the south (Phillips, 1987). A greater amount of mafic sediments are in the southern group. Therefore, there are textural and chemical differences between the two deposits.

Finally, the Lowland Valley Area is located primarily along the present Columbia River flood plain. These recently deposited alluvial sediments are mostly fine-grained sands with some silt, derived from basaltic to andesitic outcrops located in the southern Cascade Range and Columbia River Basin (Mundorff, 1964).

Description of Soils

Soils in this region developed primarily in alluvium derived from vastly different sources. Six soil associations compose the area studied in Clark County and correspond well with the physiographic areas described by Mundorff (1964). The Hesson-Olequa and Hesson-Olympic associations are located almost exclusively along the Troutdale Bench. Samples were collected only from the Hesson soil series, which is highly weathered and have well developed profiles that are moderately fine textured and become finer textured with depth (McGee, 1972).

Soils from the Hillsboro-Gee-Odne and the Hillsboro-Dollar-Cove associations developed primarily in Pleistocene sediments located on the terraces north and east of Vancouver, Wash.; the Hillsboro-Dollar-Cove association also extends south and east toward the towns of Camas and Washougal. The locations of these associations correspond closely to the northern group of the Fourth Plains and Terraces area. These soils are moderately weathered with less developed profiles than soils from the Hesson series and are generally fine textured throughout the profile (McGee, 1972).

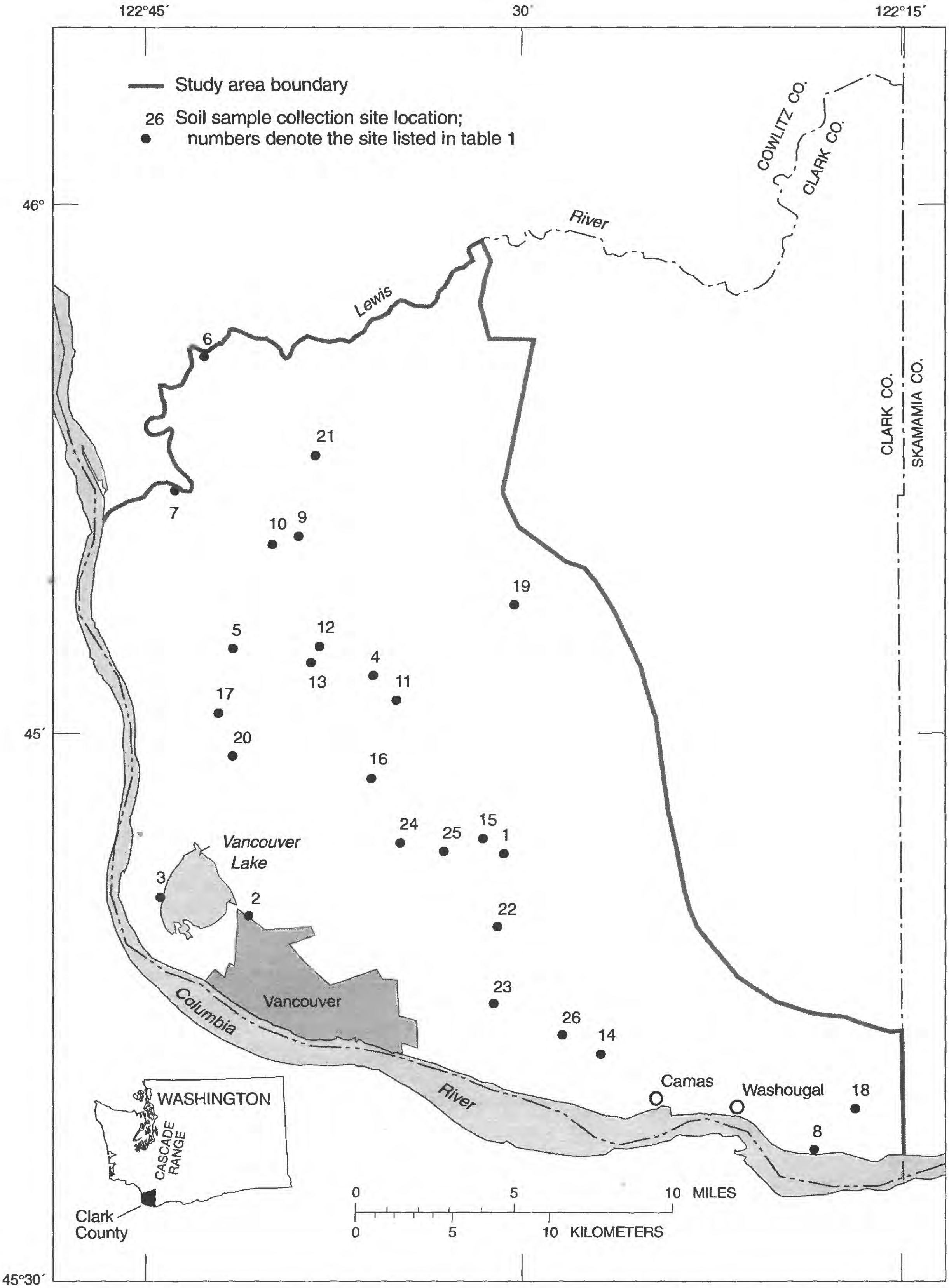

Figure 1. Location of study area and soil sample collection sites in Clark County, Wash.

Table 1.--Localities and description of soils sampled in Clark County, Wash.

Site	Sample number[1]		Latitude	Longitude	Land surface elevation (feet)	Soil series	Soil description	Soil horizon[3]	Sample depth (inches) top	Sample depth (inches) bottom
1	G10.3		454159	1223043	267	LAUREN	Dark brown loamy sand	A	8	12
	G12.2[2]						Dark brown loam	Bw	24	30
2	G20.3		454014	1224057	50	WIND RIVER	Brown loamy sand	A	5	11
	G22.2[2]						Dark grey brown loamy sand	C	24	30
3	G30.3		454050	1224424	10	SAUVIE	Silty clay loam	A	8	12
	G32.2[2]						Gravelly	Bg	24	30
4	G40.3		454653	1223558	215	DOLLAR	Dark brown clay loam	A	8	12
	G42.2[2]						Dark brown gravelly loam	Bw	24	30
5	G50.3		454742	1224135	175	GEE	Dark grey brown sandy clay	A	8	12
	G52.2[2]						Dark brown silty clay loam	Bw/A	24	30
6	G60.3		455548	1224243	32	PUYALLUP	Dark brown sandy clay loam	A	2	9
	G62.2						Brown sand	C	22	30
7	G70.3		455207	1224353	11	SAUVIE	Dark brown sandy clay loam	A	2	6
	G72.2						Dark brown sandy clay loam	Bg	24	29
8	G80.3	A	453343	1221828	20	SAUVIE	Dark brown clay	A1	2	5
	G80.3	B					Dark brown clay	A1	2	5
	G80.3	C					Dark brown clay	A1	3	7
	G80.3	D					Dark brown clay	A1	2	6
	G80.3	V					Dark brown sandy clay loam	A1	0	7
	G80.8	V					Grey brown loamy sand	A2	7	13
	G81.4	V					Light brown sandy loam	Bg1	13	20
	G82.2	A					Dark grey brown clay	Bg2	24	30
	G82.2	B					Dark grey brown clay	Bg2	24	30
	G82.2	C					Dark grey brown clay	Bg2	24	30
	G82.2	D					Dark grey brown clay	Bg2	24	30
	G82.2	V					Dark grey brown clay	Bg2	20	30
	G83.0	V					Dark brown clay	C	34	38
9	G90.3		455053	1223856	10	PUYALLUP	Dark brown clay	A	2	7
	G92.2						Dark grey brown sand	C	24	31
10	G100.3		455036	1223958	305	HILLSBORO	Dark brown loamy sand	A	2	6
	G102.2						Brown sand	B	24	30
11	G110.3		454614	1223507	360	HILLSBORO	Dark brown loamy sand	A	2	6
	G112.2						Brown sand	Bt	24	30

Table 1.--Localities and description of soils sampled in Clark County, Wash.--Continued

Site	Sample number[1]		Lat-itude	Long-itude	Land surface eleva-tion (feet)	Soil series	Soil description	Soil hori-zon[3]	Sample depth (inches) top	Sample depth (inches) bottom
12	G120.3		454745	1223805	230	GEE	Dark brown clay	A	2	6
	G122.2						Brown clay loam	Bw	24	31
13	G130.3		454717	1223827	270	ODNE	Dark grey brown clay	A	2	6
	G132.2						Dark grey brown clay	Btg	24	30
14	G140.3		453623	1222654	285	COVE	Dark grey clay	A	1	5
	G142.2						Dark grey sandy clay	Bg	24	30
15	G150.3		454222	1223140	278	DOLLAR	Dark brown loamy sand	A	2	6
	G152.2						Dark grey sandy loam	Bw	24	30
16	G160.3		454403	1223605	200	DOLLAR	Dark brown loamy sand	A	1	6
	G162.2						Dark red brown sandy loam	Bw	22	26
17	G170.3		454552	1224208	270	GEE	Dark brown sandy clay loam	A	2	6
	G172.2						Dark brown sandy clay loam	Bw	24	30
18	G180.3		453449	1221647	505	HESSON	Dark red brown sandy loam	A	2	6
	G182.2						Red brown sandy clay loam	Bt	24	30
19	G190.08	V	454854	1223018	407	COVE	Dark grey loamy sand	A1	0	2
	G190.3						Dark grey sandy loam	A2	2	6
	G190.3	V					Dark grey sand	A2	2	6
	G191.0	V					Dark grey brown sand	Bg1	6	18
	G191.6	V					Dark grey loamy sand	Bg2	18	21
	G192.2						Dark grey sandy loam	Bg3/IIC	24	30
	G192.2	V					Dark grey loamy sand	Bg3/IIC	21	36
20	G200.3	A	454442	1224133	180	HILLSBORO	Dark brown clay loam	A1	2	6
	G200.3	B					Dark brown sandy clay loam	A1	2	6
	G200.3	C					Dark brown sandy clay loam	A1	2	6
	G200.3	D					Dark brown clay loam	A1	2	6
	G200.3	V					Dark brown clay	A1	1	8
	G200.8	V					Dark brown clay loam	A2	8	12
	G201.8	A					Brown sandy clay loam	Bt1	19	24
	G201.8	B					Brown clay loam	Bt1	19	24
	G201.8	C					Brown sandy clay loam	Bt1	19	24
	G201.8	D					Brown sandy clay loam	Bt1	19	24
	G201.8	V					Brown clay loam	Bt1	19	24
	G203.0	V					Brown clay loam	Bt2	34	38
	G205.1	V					Light brown clay loam	C	53	68
21	G210.3		455307	1223815	630	HESSON	Dark brown loamy sand	A	2	6
	G212.2						Red brown sandy loam	Bt	24	30

Table 1.--Localities and description of soils sampled in Clark County, Wash.--Continued

Site	Sample number[1]	Lat-itude	Long-itude	Land surface eleva-tion (feet)	Soil series	Soil description	Soil hori-zon[3]	Sample depth (inches) top	bottom
22	G220.3	453958	1223100	205	SIFTON	Brown gravelly loamy sand	A	2	6
	G222.2					Grey brown gravelly sandy clay loam	IIC	20	30
23	G230.3	453748	1223115	305	LAUREN	Dark brown gravelly loamy sand	A	2	6
	G232.2					Brown gravelly sandy clay loam	Bw	24	30
24	G240.3	454215	1223453	205	WIND RIVER	Dark red brown sand	A	2	6
	G242.2					Dark red brown sand	C	20	24
25	G250.3	454200	1223313	270	SIFTON	Dark brown loamy sand	A	2	6
	G252.2					Dark grey brown gravelly loamy sand	IIC	24	30
26	G260.3	453654	1222824	275	LAUREN	Dark brown gravelly sandy loam	A	2	6
	G262.2					Dark brown gravelly sandy loam	Bw	24	30

[1] Sample number gives statewide region sampled, the sampling site within the region, and the approximate mean depth of the sample in feet. For example, sample G10.3 was collected from Region G (Clark County), at site 1, at a mean depth of 0.3 foot. Also, vertical-profile samples contain the additional suffix V and cluster samples contain the additional suffix A, B, C, or D, indicating the geographic locations within the site.

[2] Soil horizons determined in office using sample depth and physical soil characteristics.

[3] Horizons are relatively parallel layers of soil that have distinct characteristics that represent departures from the parent material. Typically the A horizon overlies the B horizon, together composing the solum. Subordinate distinctions within master horizons: g, strong gleying; t, accumulation of silicate clay; w, some development of color and structure. Vertical subdivisions of horizons are indicated by the numbers 1, 2, and 3 following all lower-case suffixes. Lithologic discontinuities are indicated by roman numerals preceding the master horizon notation. The C horizon overlies the parent material, and is beneath the solum. For additional information, see U.S. Department of Agriculture (1962).

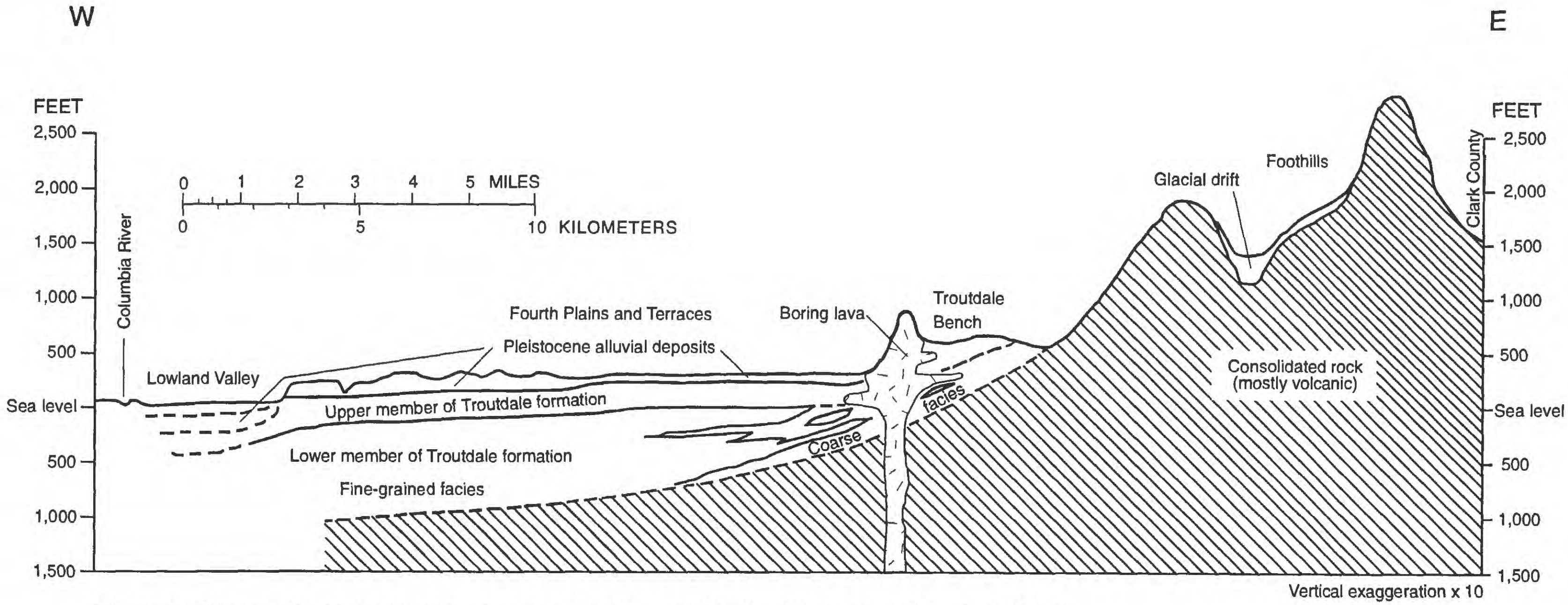

Figure 2. Generalized east-west section across Clark County, Wash. Adapted from Mundorff (1964).

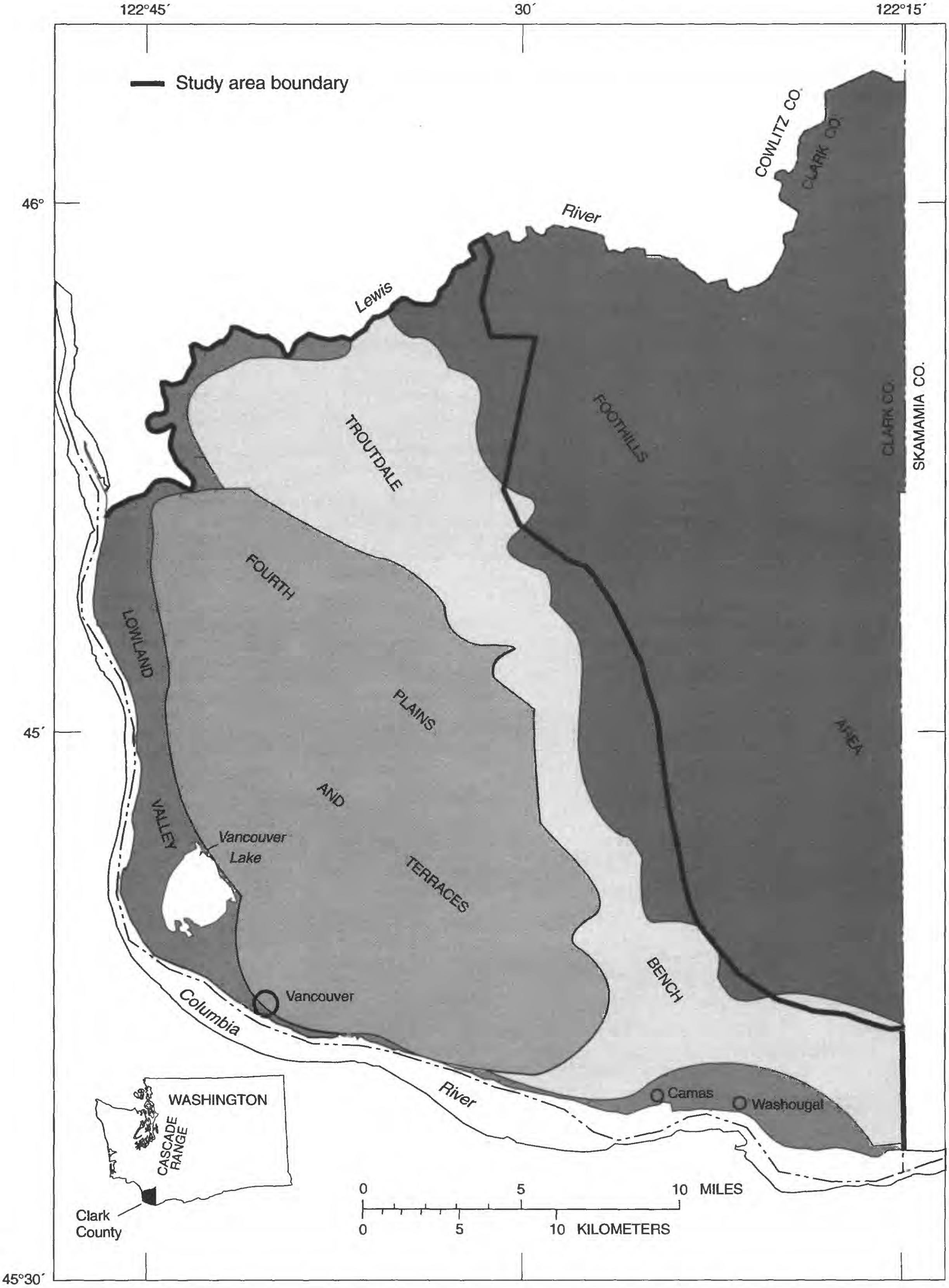

Figure 3. Physiographic areas of Clark County, Wash. Adapted from Mundorff (1964)

The Lauren-Sifton-Wind River association soils are located in the southern extent of the Fourth Plains and Terraces area and developed in coarser grained Pleistocene deltaic sediments (McGee, 1972; Phillips, 1987). As a result, soil profiles are not as well developed as the soils in the northern half of the Fourth Plains and Terraces area.

The Sauvie-Puyallup association consists of soils that developed in recent alluvium deposited along bottomlands of the Columbia and Lewis Rivers. The location of this association corresponds to the Lowland Valley Area described by Mundorff (1964). Sauvie and Puyallup soils exhibit the least developed profiles in the study area, and soil textures are fine to moderately coarse grained (McGee, 1972).

METHODS

This chapter presents the sampling design incorporated into the study, the procedures used to process soil samples, the sample identification system, and the laboratory methods used to determine the chemical and physical soil characteristics.

Sampling Design

Seventy-nine soil samples were collected from 26 sites at locations that were relatively undisturbed by human activity. All of the predominant taxonomic soil series in the study area were sampled. A stratified sampling design, described by Bennett and Franklin (1954) and by Iman and Conover (1983), was used for this study so that differences among soils within the study area could be included in the design. Samples were collected from at least two sites in each soil series. In this report the term "site" (or "sampling site") specifies an area about 1 acre or less in which one or more soil samples were collected from one or more holes. At 24 sites, a shallow standard sample and a deep standard sample were collected. Each shallow standard and deep standard sample was composited prior to analysis from sub-samples collected at similar depths from five different holes at the site. At the remaining two sites, shallow and deep samples from different locations within the site were collected and analyzed individually. These are referred to as shallow cluster and deep cluster samples. Finally, at these last two sites and at one of the other sites, vertical-profile samples were collected from a single location at five different depths, extending to about 5 feet below ground surface. These vertical-profile samples were also analyzed individually.

Every sample collected for this study was analyzed to determine the total-recoverable concentrations of 17 metals, including 13 inorganic priority pollutants listed by the Environmental Protection Agency. Fifty-three of the 79 samples collected (at least two from each soil series), including all of the vertical-profile samples and four pairs of shallow cluster and deep cluster samples, were analyzed to determine total concentrations of 40 metals. Twenty-nine samples were analyzed for concentrations of 16 metals determined by the ASTM leaching procedure (method D3987-85, American Society for Testing and Materials, 1985) and Toxicity Characteristic Leaching Procedure (TCLP; method 1311, U.S. Environmental Protection Agency, 1990a; U.S. Environmental Protection Agency, 1990b) and for cation-exchange capacity (CEC). Fifty-four samples were also analyzed for organic and inorganic carbon content, and 6 samples were analyzed for total petroleum hydrocarbons (TPH) and polychlorinated biphenyls (PCBs).

Sample-Number Identification System

Soil-sample identifiers are alphanumeric labels (table 1) that identify the site, hole, and depth. The first letter (G) indicates the statewide region sampled. The numbers following identify the sampling site within the region and the approximate mean depth of the sample, in feet below land surface. For example, G10.3 was collected from Region G (Clark County), at site 1, at a mean depth of 0.3 foot. The vertical-profile samples contain the additional suffix V, and the cluster samples contain the additional suffix A, B, C, or D, indicating the geographic locations within the site.

Sample Collection and Preparation

Samples from sites 1, 2, 3, 4, and 5 were collected in the summer of 1990, and all other samples were collected in April and May of 1991. The shallow standard sample was composited from material collected from depths of from 2 to 6 inches below ground surface, typically the A horizon, and the deep standard sample was composited from material collected from depths of from 24 to 30 inches below ground surface, typically the B horizon. The shallow cluster and deep cluster samples were collected from the same depths as the shallow standard and deep standard samples. If the B horizon was not present, the deep standard sample was collected from the C horizon. The vertical-profile samples were collected from material at five different depths, typically one sample from the A horizon, two samples from the B horizon, and two samples from the C horizon.

A shovel was used to dig a hole of about 12 to 24 inches in diameter to a depth just above where a sample was to be collected. A stainless-steel soil auger was used to collect 1 to 2 liters of material from the 4-inch layer below the bottom of the hole. The material from each hole was sieved in the field through a 19.0 millimeter (mm) stainless-steel sieve and placed in a 20-liter plastic bucket. To produce the standard samples, a stainless-steel scoop was used to thoroughly mix the material composited from five holes. About 3 liters of each sample were placed in 4-liter plastic containers for additional sieving and splitting in the laboratory. Subsamples to be used for determining concentrations of PCBs and TPH were sieved in the field through a 2-mm stainless-steel sieve and stored in a glass jar on ice. Before the material was collected from each depth, all sampling and processing equipment was washed with tap water and detergent (Alconox), then rinsed sequentially with tap water and distilled water. A 60:40 acetone:hexane solution also was used to rinse the equipment prior to the collection of the second subsample.

Representative sample splits were produced by flattening, mixing, and quartering the samples (method 3987-85; American Society for Testing and Materials, 1985) at the USGS field-support water-quality laboratory facility in Tacoma, Wash. All sample splits, except those used for determining particle-size distribution, were dry sieved to remove particles larger than 2 mm. Sample splits to be analyzed by the total method were additionally wet sieved (through a polypropylene sieve) to remove particles larger than 63 microns in diameter.

Laboratory Methods

Four methods, the total, total-recoverable, ASTM, and TCLP, were used to determine metals concentrations in soils. Although each method utilizes different digestion and extraction procedures, all methods produce an aqueous solution that is analyzed by standard methods, such as atomic-absorption spectroscopy or inductively coupled plasma emission spectroscopy (ICPES) (Fishman and Friedman, 1985; U.S. Environmental Protection Agency, 1986). Differences among the digestion and extraction procedures of these methods affect the amount of metals concentrated in the solution, resulting in reported metals concentrations that can differ by several orders of magnitude. Laboratory minimum reporting levels for each method are given in table 2.

With the total method, hot, concentrated nitric, hydrofluoric, and perchloric acids were used sequentially to dissolve at least 95 percent of the sample (Fishman and Friedman, 1985). This method is frequently used in geochemical studies where the concentrations of the entire amount of the metals present is of interest. The extracted solutions then were analyzed using ICPES to determine all metals concentrations. All total analyses were performed by the Geologic Division Laboratory of the U.S. Geological Survey in Arvada, Colo.

With the total-recoverable method (method 3050; U.S. Environmental Protection Agency, 1986), a hot solution of concentrated nitric and hydrochloric acids is used to digest the soil samples; less than 95 percent of the metals present in the sample is extracted (Fishman and Friedman, 1985). Although the soil is not completely digested, most of the metals not strongly held within mineral matrices are released into solution. Thus, the quantity of the metal released into solution depends on many factors, including the mineral composition, particle-size distribution, and organic carbon content of the sample. As a result, this method is widely used in environmental investigations to determine the concentrations of metals in soils that ultimately may be available for biological uptake. Concentrations of all metals, except arsenic and mercury, were determined by ICPES. Concentrations of arsenic in the extracts were determined by graphite-furnace atomic-absorption spectroscopy (GFAAS), and concentrations of mercury were determined by cold-vapor atomic-absorption spectroscopy (CVAAS). These analyses were performed at Ecology's Manchester Environmental Laboratory, in Manchester, Wash.

The two leaching procedures, ASTM and TCLP, are used to approximate the solubility and mobility of metals under extreme contaminated conditions in soils. The ASTM method required distilled water to be mixed with the sample (1.4 liters of water to 70 grams of soil) and shaken for 18 hours, after which the solution was extracted and analyzed. The TCLP method differed from the ASTM method in that an acetic acid solution, rather than distilled water, was mixed with the sample, and the soil-solution pH was maintained at 5 throughout the procedure. Concentrations of mercury in the leachate were determined by CVAAS, and concentrations of the remaining metals were determined by ICPES. These analyses were also performed at Ecology's laboratory.

Table 2.--Analytical methods used and metals determined for soils in Clark County, Wash.

[Values in parentheses are given in milligrams per liter of leachate; --, lack of a reporting level indicates that analysis was not performed; ASTM, American Society for Testing and Materials method D3987-85; TCLP, Toxicity Characteristic Leaching Procedure, U.S. Environmental Protection Agency method 1311]

Metal		Minimum laboratory reporting levels by analytical method, in milligrams per kilogram of dry soil			
Symbol	Name	Total	Total recoverable	ASTM and	TCLP
Ag	Silver	2	0.2	--	--
Al	Aluminum	500	7	2.0	(0.1)
As	Arsenic	10	0.5	0.6	(0.03)
Au	Gold	8	--	--	--
Ba	Barium	1	--	0.2	(0.01)
Be	Beryllium	1	0.5	0.02	(0.001)
Bi	Bismuth	10	--	--	--
Ca	Calcium	500	--	--	--
Cd	Cadmium	2	0.2	0.04	(0.002)
Ce	Cerium	4	--	--	--
Co	Cobalt	1	--	--	--
Cr	Chromium	1	1.5	0.1	(0.005)
Cu	Copper	1	1.0	0.06	(0.003)
Eu	Europium	2	--	--	--
Fe	Iron	500	2.0	0.4	(0.02)
Ga	Gallium	4	--	--	--
Ho	Holmium	4	--	--	--
Hg	Mercury	--	0.004	0.001	(0.00005)
K	Potassium	500	--	--	--
La	Lanthanum	2	--	--	--
Li	Lithium	2	--	--	--
Mg	Magnesium	50	--	--	--
Mn	Manganese	4	1.0	0.02	(0.001)
Mo	Molybdenum	2	--	--	--
Na	Sodium	50	--	--	--
Nb	Niobium	4	--	--	--
Nd	Neodymium	4	--	--	--
Ni	Nickel	2	7	0.2	(0.01)
P	Phosphorus	50	--	--	--
Pb	Lead	4	10	0.02	(0.001)

Table 2.--Analytical methods used and metals determined for soils in Clark County, Wash.--Continued

Metal		Minimum laboratory reporting levels by analytical method, in milligrams per kilogram of dry soil			
Symbol	Name	Total	Total recoverable	ASTM and	TCLP
Sb	Antimony	--	3.0	0.6	(0.03)
Sc	Scandium	2	--	--	--
Se	Selenium	--	0.5	0.04	(0.002)
Sn	Tin	10	--	--	--
Sr	Strontium	2	--	--	--
Ta	Tantalum	40	--	--	--
Th	Thorium	4	--	--	--
Ti	Titanium	50	1.5	--	--
Tl	Thallium	--	5.0	1.0	(0.05)
U	Uranium	100	--	--	--
V	Vanadium	2	--	--	--
Y	Yttrium	2	--	--	--
Yb	Ytterbium	1	--	--	--
Zn	Zinc	4	2	0.4	(0.02)

The particle-size distributions of the samples were determined at the USGS sediment laboratory in Vancouver, Wash. A mechanical shaker with standard size sieves from 19 mm to 0.063 mm was used to determine the abundance of sand- and gravel-sized particles in the soil, as described by Guy (1977). Determinations of the relative abundance of silt- and clay-sized particles were made using the sedigraph technique described by Coakley and Syvitski (1991).

Total, inorganic, and organic carbon concentrations were determined at the USGS National Water Quality Laboratory. Splits of each sample were made, and total carbon concentrations were determined by complete oxidation of one sample split. The other sample split was treated with hydrochloric acid and the inorganic carbon concentrations were determined using a modified VanSlyke apparatus (Wershaw and others, 1987). The quantity of organic carbon was calculated by the difference.

The soil-solution pH for the samples was determined by two commonly used methods (Beckman Instruments, Inc., 1983; and Falen and Fosberg, 1989). The first method consists of adding 20 milliliters (mL) of deionized water to 20 grams of soil and mixing the resulting slurry periodically for 30 minutes. After 30 minutes, the pH of the slurry is measured. The second method involves adding 1 milliliter of 1 molar calcium chloride solution to the slurry and mixing it intermittently for an additional 30 minutes.

STATISTICAL ANALYSIS OF METALS CONCENTRATIONS IN SOILS

In this chapter, summary statistics of the data are presented and discussed to illustrate the magnitude and variability of metals concentration within Clark County. The data for each metal are tested to determine if they were sampled from populations that were normally or log-normally distributed. Individual sources of variance that can be reasonably isolated are characterized so that sample variance can be accounted for and the reliability of baseline total-recoverable metals concentrations can be maximized. The complete set of data for this study is presented in tables A1 through A6, at the end of this report. Table A1 contains the total metals concentration data. Table A2 contains all of the total-recoverable, ASTM, TCLP metals concentrations and the corresponding total metals concentrations. Soil-solution pH, electrical conductivity, TPH, and PCB values are listed in table A3, and organic and inorganic carbon values are listed in table A4. Additionally, values determined for particle size distributions and CEC are listed in tables A5 and A6, respectively.

Summary Statistics

Summary statistics of the data were calculated to illustrate the magnitude and variability of metals concentrations determined by the four different laboratory methods (tables 3 through 6). A resampling method (Bootstrap; described by Efron, 1982) was used to calculate sample means and medians because the data of most metals were sampled from populations that were not normally or log-normally distributed.

Concentrations of metals determined by the total method for samples collected in Clark County were within the ranges of values given by Shacklette and others (1971) and by Shacklette and Boerngen (1984) for surficial material collected throughout the conterminous United States and by Gough and others (1988) for surficial material collected at various locations in Alaska. As might be expected, the ranges of values in this study were considerably less than those given by Shacklette and others (1971), Shacklette and Boerngen (1984), and Gough and others (1988). Furthermore, it was apparent from the data presented by Shacklette and others (1971) and by Shacklette and Boerngen (1984) that arithmetic mean concentrations of metals in soils throughout the conterminous United States were considerably different from arithmetic mean metals concentrations in Clark County. For example, in Clark County arithmetic mean concentrations of arsenic, chromium, copper, nickel, vanadium, and zinc were determined by the total method to be 10, 60, 37, 24, 179, and 112 mg/kg, respectively, whereas arithmetic mean concentrations of these same metals given by Shacklette and Boerngen (1984) were 5.2, 37, 17, 13, 58, and 48 mg/kg, respectively.

Arithmetic mean concentrations of most metals determined by the total method were greater than arithmetic mean concentrations of metals determined by the total-recoverable, ASTM, or TCLP methods. Furthermore, arithmetic mean concentrations of metals determined by the total-recoverable method were greater than arithmetic mean concentrations of metals determined by the ASTM and TCLP methods, and all but antimony, selenium, silver, and thallium were detected by the total-recoverable method. Only aluminum, beryllium, copper, iron, manganese, and zinc were detected by the ASTM method, and only aluminum, barium, copper, iron, manganese, and zinc were detected by the TCLP method.

Frequency Distribution of Metals Concentrations in Soils

The background cleanup standards calculated by Ecology depend, in part, on the data about the distribution of the background metals concentrations (Hardin and Gilbert, 1993). As a result, for this study the probability plot correlation coefficient test (Looney and Gulledge, 1985a, b) and the D'Agostino test (D'Agostino, 1990) were each used to test two null hypotheses: (1) that the data were sampled from populations that were normally distributed and (2) that the data were sampled from populations that were log-normally distributed. The results of the two tests were consistent.

The population distributions of most metals could not be determined from the samples collected (table 7). However, the data of some metals, such as copper determined by either the total or the total-recoverable method, were sampled from populations that were distributed log-normally, and the data of other metals, such as zinc (determined by the total-recoverable method), were apparently sampled from a normally distributed population. In addition, the apparent distributions of some metals concentrations, such as total-recoverable arsenic, differed between shallow and deep groupings.

Rigorous probabilistic interpretation of these statistics requires that the data follow a normal distribution, which is rarely the case. Frequently, logarithms of the data values are used statistically because they are normally distributed (log-normal distribution). This is a popular transformation, but it is not without problems. The logarithmic transformations (as are many others) are biased (Gilbert, 1987); therefore, the back-transformed values are also biased relative to the actual data values. Thus, methods to correct a distribution bias are only approximate and may introduce more error than that arising from not transforming in the first place. Because of this, the data were not transformed in the following statistical analyses.

Table 3.*--Summary statistics for concentrations of metals in soil samples as determined by the total method in Clark County, Wash.*

[Concentrations are in milligrams per kilogram of dry soil, except for Al, Ca, Fe, K, Mg, Na, and P, which are in percent; tot., total number of samples analyzed; det., number of samples with concentrations equal to or greater than the analyzing laboratory's minimum reporting values; --, indicates statistic not computed because concentrations in all samples were less than laboratory's minimum reporting value; <, less than]

Metal	Number of samples tot./det.	Arithmetic mean	Median	Standard deviation	Coefficient of variation (percent)	Mini-mum	Maxi-mum	90th percentile
Silver	53/0	<2	<2	--	--	<2	<2	<2
Aluminum	53/53	8.4	8.4	0.93	11	6.8	10.0	9.8
Arsenic	50/0	<10.3	<10	--	--	<10	<20	<10
Gold	53/0	<8	<8	--	--	<8	<8	<8
Barium	53/53	626	668	133	21	340	820	767
Beryllium	53/53	1.4	1	0.47	35	1	2	2
Bismuth	53/0	<10	<10	--	--	<10	<10	<10
Calcium	53/53	1.25	0.96	0.62	50	0.54	3.0	2.3
Cadmium	53/0	<2	<2	--	--	<2	<2	<2
Cerium	53/53	68.5	69	12.4	18	36	89	83
Cobalt	53/53	20.7	19	5.92	29	11	34	29
Chromium	53/53	59.8	60.6	12.2	20	27	81	75
Copper	53/53	36.6	34.5	15.3	42	17	76	63
Europium	53/0	<2	<2	--	--	<2	<2	<2
Iron	53/53	5.7	5.5	1.43	25	3.7	9.0	8.1
Gallium	53/53	21.5	21	3.03	14	16	28	27
Holmium	53/0	<4	<4	--	--	<4	<4	<4
Potassium	53/53	1.18	1.15	0.36	30	0.66	1.9	1.7
Lanthanum	53/53	35.3	35	6.66	19	18	46	43
Lithium	53/53	23.8	24	3.20	13	16	30	27
Magnesium	53/53	0.82	0.79	0.2	24	0.5	1.6	1.1
Manganese	53/53	978	990	334	34	430	1,800	1,400
Molybdenum	53/0	<2	<2	--	--	<2	<2	<2
Sodium	53/53	1.25	1.2	0.45	36	0.67	2.9	1.73
Niobium	53/53	15.5	16	3.36	22	8	28	18
Neodymium	53/53	32.8	34	5.60	17	20	44	40
Nickel	53/53	24.3	24	3.68	15	16	30.7	29
Phosphorus	53/53	0.15	0.14	0.05	37	0.05	0.33	0.21
Lead	53/53	16.9	16.7	3.74	22	12	27.3	21

Table 3.--Summary statistics for concentrations of metals in soil samples as determined by the total method in Clark County, Wash.--Continued

Metal	Number of samples tot./det.	Arithmetic mean	Median	Standard deviation	Coefficient of variation (percent)	Mini- mum	Maxi- mum	90th percentile
Scandium	53/53	20.4	18	6.69	33	12	38	29
Tin	53/0	<5	<5	--	--	<5	<5	<5
Strontium	53/53	210	200	63.9	30	110	420	317
Tantalum	53/0	<40	<40	--	--	<40	<40	<40
Thorium	53/53	10.7	11	3.59	33	4	21	14.7
Uranium	53/0	<100	<100	--	--	<100	<100	<100
Vanadium	53/53	179	170	42.9	24	100	270	250
Yttrium	53/53	22.2	19.5	7.85	35	13	44	34
Ytterbium	53/53	2.5	2	0.67	27	1.7	4	3
Zinc	53/53	112	110	22.9	20	64	177	130

***Table 4.**--Summary statistics for concentrations of metals in soil samples as determined by the total-recoverable method in Clark County, Wash.*

[Concentrations are in milligrams per kilogram of dry soil, except Al and Fe, which are in percent; tot., indicates total number of samples analyzed; det., indicates number of samples with concentrations equal to or greater than the analyzing laboratory's minimum reporting values; --, indicates statistic not computed because concentrations in all samples were less than laboratory's minimum reporting value; <, less than]

Metal	Number of samples tot./det.	Arithmetic mean	Median	Standard deviation	Coefficient of variation (percent)	Mini-mum	Maxi-mum	90th percentile
Silver	79/0	<0.31	<0.30	--	--	<0.2	<0.63	<0.38
Aluminum	79/79	3.48	3.29	1.31	38	1.13	6.98	5.09
Arsenic	79/79	3.8	3.2	2.18	57	0.5	9.8	7.2
Beryllium	79/79	1.4	1.5	0.49	35	0.19	2.13	1.95
Cadmium	79/79	0.86	0.89	0.37	43	0.2	1.5	1.3
Chromium	79/79	21.0	21.4	6.23	30	2.6	32.8	28.7
Copper	79/79	21.1	21.2	9.43	45	8.6	54	26.7
Iron	79/79	33.98	33.7	1.29	32	1.39	6.94	5.68
Mercury	79/78	<0.028	0.029	>0.013	>47	<0.004	0.073	<0.041
Manganese	79/79	879	912	425	48	70	2,140	1,370
Nickel	79/79	18.0	16.5	14.6	81	6	117	21
Lead	79/79	10.6	9.2	7.34	69	2	54	16
Antimony	79/0	<3.1	<3	--	--	<3	<5.2	<3.2
Selenium	79/0	<3.7	<5	--	--	<0.15	<8.4	<5.4
Thallium	79/0	<5.9	<5.0	--	--	<0.5	<14	<9.1
Zinc	79/79	75.9	78.4	22.0	29	13.1	130	99

Table 5.--Summary statistics for concentrations of metals in soil samples as determined by the ASTM method in Clark County, Wash.

[Concentrations are in milligrams per kilogram of dry soil; tot., indicates total number of samples analyzed; det., indicates number of samples with concentrations equal to or greater than the analyzing laboratory's minimum reporting values; --, indicates statistic not computed because concentrations in all samples were less than laboratory's minimum reporting value; <, less than; >, greater than]

Metal	Number of samples tot./det.	Arithmetic mean	Median	Standard deviation	Coefficient of variation (percent)	Mini-mum	Maxi-mum	90th percentile
Silver	29/0	<3.0	<3.0	--	--	<3	<3	<3
Aluminum	29/29	177	140	128	72	39	519	362
Arsenic	29/0	<30	<30	--	--	<30	<30	<30
Barium	29/29	<102	71.0	90.8	89	3.8	260	229
Beryllium	29/29	1.6	1	3.53	213	1	20	1
Cadmium	29/0	<2.0	<2.0	--	--	<2	<2.3	<2
Chromium	29/0	<5.0	<5.0	--	--	<5	<5	<5.0
Copper	29/8	<4.4	<3.0	>3.64	>83	<3.0	20	6.7
Iron	29/28	<174	141	>142	>81	<20	494	447
Mercury	29/0	<0.054	<0.050	--	--	<0.05	<0.16	<0.05
Manganese	29/27	<8.4	5.3	>7.0	>83	<1.0	28.2	20.4
Nickel	29/0	<10.6	<10.0	--	--	<10	<20	<11
Lead	29/0	<1.9	<1.0	--	--	<1.0	<20	<2.5
Antimony	29/0	<29.6	<30.0	--	--	<20	<30	<30
Selenium	29/0	<2.0	<2.0	--	--	<2	2	<2
Thallium	29/0	<49	<50	--	--	<20	<50	<50
Zinc	29/28	<22.9	27.0	>12.3	>54	<4	46.8	35.5

***Table 6.**--Summary statistics for concentrations of metals in soil samples as determined by the TCLP method in Clark County, Wash.*

[Concentrations are in milligrams per kilogram of dry soil; tot., indicates total number of samples analyzed; det., indicates number of samples with concentrations equal to or greater than the analyzing laboratory's minimum reporting values; --, indicates statistic not computed because concentrations in all samples were less than laboratory's minimum reporting value; <, less than; >, greater than]

Metal	Number of samples tot./det.	Arithmetic mean	Median	Standard deviation	Coefficient of variation (percent)	Minimum	Maximum	90th percentile
Silver	29/0	<3.0	<3.0	--	--	<3	<3	<3
Aluminum	29/28	<434	424	>187	>43	<100	748	682
Arsenic	29/0	<30	<30	--	--	<30	<30	<30
Barium	29/29	881	952	373	42	163	1,610	1,295
Beryllium	29/0	<1.7	<1.0	--	--	<1	<20	<1
Cadmium	29/0	<2.2	<2.0	--	--	<2	<6.2	<2.3
Chromium	29/0	<5.0	<5.0	--	--	<5	<5	<5
Copper	29/29	5.3	3.0	3.93	74	2.0	20	9.45
Iron	29/28	<71.4	47.0	>137	>192	<13	770	84
Mercury	29/0	<0.051	<0.050	--	--	<0.05	<0.07	<0.05
Manganese	29/8	<35.9	<29.1	>32.08	>89	<4.6	181	<52
Nickel	29/0	<11	<10	--	--	<10	<20	<14
Lead	29/0	<3.2	<2.3	--	--	<1.0	<20	<3.8
Antimony	29/0	<29.7	<30.0	--	--	<20	<32	<30
Selenium	29/0	<2.7	<2.0	--	--	<2	<2	<2
Thallium	29/0	<49	<50	--	--	<20	<51	<50
Zinc	29/27	<170	159	>64.0	>38	<59	330	269

Table 7.--Frequency distributions of the concentrations of metals for soils sampled in Clark County, Wash.

[N and L signify that one cannot reject with 90 percent confidence the null hypothesis that the data are normally or log-normally distributed, respectively, as determined by the probability plot correlation coefficient method and by D'Agostino's test; O signifies that the null hypothesis can be rejected; -- indicates that concentrations were not determined or that many were less than the laboratory's minimum reporting value]

Metal	Total method, Sample depth: All	Total method, Sample depth: Shallow	Total method, Sample depth: Deep	Total-recoverable method, Sample depth: All	Total-recoverable method, Sample depth: Shallow	Total-recoverable method, Sample depth: Deep
Ag	--	--	--	--	--	--
Al	N,L	N,L	N,L	N,L	N,L	N,L
As	O,O	N,L	O,O	O,L	O,L	N,O
Au	--	--	--	--	--	--
Ba	O,O	N,O	O,O	--	--	--
Be	--	--	--	N,O	N,O	N,O
Bi	--	--	--	--	--	--
Ca	O,L	O,L	O,L	--	--	--
Cd	--	--	--	N,O	N,O	N,L
Ce	O,O	O,O	O,O	--	--	--
Co	N,L	N,L	N,L	--	--	--
Cr	N,O	N,O	N,L	O,O	N,O	O,O
Cu	O,L	N,L	O,L	O,L	O,L	O,L
Eu	--	--	--	--	--	--
Fe	N,L	N,L	N,L	N,O	N,L	N,O
Ga	N,L	N,L	N,L	--	--	--
Ho	--	--	--	--	--	--
Hg	--	--	--	O,O	N,L	O,L
K	N,O	N,L	N,L	--	--	--
La	N,O	N,O	O,O	--	--	--
Li	N,O	N,O	N,O	--	--	--
Mg	N,L	N,L	O,L	--	--	--
Mn	N,L	N,L	N,L	N,O	N,L	N,O
Mo	--	--	--	--	--	--
Na	O,O	O,L	O,O	--	--	--

Table 7.--Frequency distributions of the concentrations of metals for soils sampled in Clark County, Wash.--Continued

Metal	Total method Sample depth All	 Shallow	 Deep	Total-recoverable method Sample depth All	 Shallow	 Deep
Nb	O,O	O,O	N,O	--	--	--
Nd	N,O	N,O	N,L	--	--	--
Ni	N,L	N,L	N,L	O,O	O,O	N,O
P	O,L	O,L	N,L	--	--	--
Pb	O,O	N,L	N,L	O,O	O,O	N,O
Sb	--	--	--	--	--	--
Sc	O,L	N,L	N,O	--	--	--
Se	--	--	--	--	--	--
Sn	--	--	--	--	--	--
Sr	O,O	O,O	O,L	--	--	--
Ta	--	--	--	--	--	--
Th	N,L	N,L	N,O	--	--	--
Ti	N,L	N,L	N,L	--	--	--
Tl	--	--	--	--	--	--
U	--	--	--	--	--	--
V	N,O	N,L	N,L	--	--	--
Y	O,L	N,O	N,L	--	--	--
Yb	N,O	O,O	N,L	--	--	--
Zn	N,L	N,L	N,O	N,O	N,O	O,O
C	O,L	O,L	O,L	--	--	--

Sources of Variance

The total variance of a given variable (for example, concentration of a metal) can be thought of as the sum of variance contributed by different causes. For example, the total variance of arsenic may include the variances among the different soil series sampled; among sample sites in a given soil series; within the different localities comprising a given site; among different soil horizons (or different depths) sampled; within individual soil samples; due to sample preparation; within the laboratory analysis; and from random error. Thus, the total variance was considered, as were estimates of those sources of variance that could be reasonably isolated, which include between soil series (groups of sites within different series), within a site (different localities and depths), and between depths or horizons (all samples).

Although the amount each source of variance contributed to the total variance could not be determined, it was apparent that the variance between soil series and between depths or horizons did largely affect the total variance. Similarly, the variance within a site apparently contributed significantly to the total variance. Although it also was likely that the variance among sites affected the total variance, this source of variance could not be determined. The variance due to sample collection, laboratory analyses, and random error also could not be determined; however, it is likely that these sources of variance contributed small if not negligible amounts to the total variance. However, this does not suggest these sources of variance should be disregarded or that steps to minimize these and other sources of variance were or should not be incorporated into the collection, processing, or analyses of samples in this or future studies.

Total Variance

Within the study area, the variance of total metals concentrations was consistently less than the variance of metals concentrations determined by the total-recoverable, ASTM, and TCLP methods. Coefficients of variation (CV) were used to estimate the total variance over the area sampled. The CV for concentrations of 28 metals determined by the total method ranged from 11 percent for aluminum to 50 percent for calcium (table 3), whereas the CV of 12 metals determined by the total-recoverable method ranged from 29 percent for zinc to 81 percent for nickel (table 4). This means roughly 95 percent of the sample values (± 2 standard deviations of the mean) would lie within ± 22 percent of the mean for total aluminum, ± 100 percent of the mean for total calcium, ± 58 percent of the mean for total-recoverable zinc, and ± 162 percent for total-recoverable nickel. Furthermore, the CV for concentrations of aluminum, barium, beryllium, copper, iron, and manganese determined by the ASTM and iron and manganese determined by TCLP methods were greater than 66 percent (tables 5 and 6).

Variance Between Soil Series

The variance of metals concentrations among groups of sites within different soil series was determined by a one-way analysis of variance. The mean concentrations of total aluminum, chromium, iron, lead, manganese, nickel, and zinc of at least one soil series differ from the mean concentrations for the same metals in another soil series (table 8). For example, mean concentrations of total aluminum in samples collected from the Sifton, Puyallup, Dollar, Cove, and Lauren soil series all differ significantly from mean concentrations determined for samples collected from the Gee, Hillsborough, Suavie, and Hesson soil series. Similarly, the mean concentrations of total-recoverable aluminum, arsenic, beryllium, cadmium, chromium, iron, lead, manganese, and zinc of at least one soil series differ from total-recoverable mean concentrations for the same metals in the other soil series (table 9). This is important because it suggests that the metals concentrations of the particular soil series being sampled must be considered when the extent of contamination is being determined at a potentially contaminated site. Similar comparisons can be drawn for the other metals and soil series.

Variance Within a Site

The variance of metals concentrations of cluster samples may be used as an approximation of the within-site variance for all sites. In general, the CV for concentrations of most metals determined for cluster samples were less than 20 percent. Yet care must be used in comparing the variance of metals concentrations of cluster-samples from one site with another, since each site comes from a different soil series. Furthermore, comparisons between the variance of metals concentrations of cluster samples with standard samples also may be somewhat inappropriate because the data from the two types of sites were not determined in the same manner; the mean metals concentrations of cluster samples were obtained by analyzing five separate samples and taking the average of those five values, whereas the corresponding value for the

Table 8.*--One-way analysis of variance and multiple range test among mean concentrations of metals determined by the total method for different soil series in Clark County, Wash.*

[mg/kg, milligrams per kilogram of dry soil; S indicates a significant difference (at a 95 percent confidence level) between metals concentrations in different soil series; letter codes for the soils are arranged according to increasing mean concentrations, these codes differ for each metal; -- indicates no significant difference between metals concentrations in different soil series]

Code	Soil	Mean concentration (percent)	Variable: Aluminum A	B	C	D	E	F	G	H	I	J
A	Gee	7.48	--	--	--	--	S	S	S	S	S	S
B	Hillsborough	7.67	--	--	--	--	S	S	S	S	S	S
C	Sauvie	7.71	--	--	--	--	S	S	S	S	S	S
D	Hesson	7.75	--	--	--	--	S	S	S	S	S	S
E	Sifton	8.7	S	S	S	S	--	--	--	--	--	S
F	Puyallup	8.7	S	S	S	S	--	--	--	--	--	S
G	Dollar	8.83	S	S	S	S	--	--	--	--	--	S
H	Cove	8.97	S	S	S	S	--	--	--	--	--	S
I	Lauren	9.52	S	S	S	S	--	--	--	--	--	--
J	Wind	9.9	S	S	S	S	S	S	S	S	--	--

Code	Soil	Mean concentration (mg/kg)	Variable: Chromium A	B	C	D	E	F	G	H	I	J
A	Cove	51.4	--	--	--	--	--	--	--	S	S	S
B	Sifton	51.5	--	--	--	--	--	--	--	--	S	S
C	Lauren	54.8	--	--	--	--	--	--	--	--	S	S
D	Gee	59.5	--	--	--	--	--	--	--	--	S	S
E	Puyallup	60.0	--	--	--	--	--	--	--	--	S	S
F	Hillsborough	60.4	--	--	--	--	--	--	--	--	S	S
G	Wind	60.5	--	--	--	--	--	--	--	--	S	S
H	Dollar	62.8	S	--	--	--	--	--	--	--	--	--
I	Sauvie	71.5	S	S	S	S	S	S	S	--	--	--
J	Hesson	75.5	S	S	S	S	S	S	S	--	--	--

***Table 8.**--One-way analysis of variance and multiple range test among mean concentrations of metals determined by the total method for different soil series in Clark County, Wash.--Continued*

Code	Soil	Mean concentration (percent)	Variable: Iron A	B	C	D	E	F	G	H	I	J
A	Sauvie	4.56	--	--	--	--	--	S	S	S	S	S
B	Gee	4.65	--	--	--	--	--	S	S	S	S	S
C	Hesson	4.8	--	--	--	--	--	--	--	S	S	S
D	Cove	4.97	--	--	--	--	--	--	--	S	S	S
E	Hillsborough	4.97	--	--	--	--	--	--	--	S	S	S
F	Dollar	5.85	S	S	--	--	--	--	--	--	S	S
G	Puyallup	5.9	S	S	--	--	--	--	--	--	S	S
H	Sifton	6.35	S	S	S	S	S	--	--	--	S	S
I	Lauren	7.98	S	S	S	S	S	S	S	S	--	--
J	Wind	8.55	S	S	S	S	S	S	S	S	--	--

Code	Soil	Mean concentration (mg/kg)	Variable: Manganese A	B	C	D	E	F	G	H	I	J
A	Odne	614	--	--	--	--	S	S	S	S	S	S
B	Sauvie	815	--	--	--	--	--	--	S	S	S	S
C	Hillsborough	819	--	--	--	--	--	--	S	S	S	S
D	Gee	825	--	--	--	--	--	--	S	S	S	S
E	Dollar	842	S	--	--	--	--	--	S	S	S	S
F	Puyallup	1,050	S	--	--	--	--	--	--	--	S	S
G	Hesson	1,350	S	S	S	S	S	--	--	--	--	--
H	Sifton	1,350	S	S	S	S	S	--	--	--	--	--
I	Lauren	1,450	S	S	S	S	S	S	--	--	--	--
J	Wind	1,500	S	S	S	S	S	S	--	--	--	--

Table 8.--One-way analysis of variance and multiple range test among mean concentrations of metals determined by the total method for different soil series in Clark County, Wash.--Continued

Code	Soil	Mean concentration (mg/kg)	A	B	C	D	E	F	G	H	I	J
						Variable: Nickle						
A	Cove	20.1	--	--	--	--	--	--	--	--	S	S
B	Lauren	22.8	--	--	--	--	--	--	--	--	--	S
C	Gee	23.0	--	--	--	--	--	--	--	--	--	S
D	Hillsborough	23.6	--	--	--	--	--	--	--	--	--	S
E	Sifton	24.0	--	--	--	--	--	--	--	--	--	--
F	Puyallup	25.0	--	--	--	--	--	--	--	--	--	--
G	Dollar	25.3	--	--	--	--	--	--	--	--	--	--
H	Hesson	26.5	--	--	--	--	--	--	--	--	--	--
I	Wind	28.0	S	--	--	--	--	--	--	--	--	--
J	Sauvie	28.7	S	S	S	S	--	--	--	--	--	--

Code	Soil	Mean concentration (mg/kg)	A	B	C	D	E	F	G	H	I	J
						Variable: Lead						
A	Cove	15.3	--	--	--	--	--	--	--	--	--	S
B	Hesson	15.5	--	--	--	--	--	--	--	--	--	--
C	Puyallup	16.5	--	--	--	--	--	--	--	--	--	--
D	Gee	16.5	--	--	--	--	--	--	--	--	--	--
E	Dollar	16.7	--	--	--	--	--	--	--	--	--	--
F	Hillsborough	17.0	--	--	--	--	--	--	--	--	--	--
G	Wind	17.0	--	--	--	--	--	--	--	--	--	--
H	Lauren	17.0	--	--	--	--	--	--	--	--	--	--
I	Sauvie	19.3	--	--	--	--	--	--	--	--	--	--
J	Sifton	21.5	S	--	--	--	--	--	--	--	--	--

Table 8.--One-way analysis of variance and multiple range test among mean concentrations of metals determined by the total method for different soil series in Clark County, Wash.--Continued

Code	Soil	Mean concentration (mg/kg)	Variable: Zinc A	B	C	D	E	F	G	H	I	J
A	Cove	81	--	--	--	--	--	--	--	--	S	S
B	Gee	105	--	--	--	--	--	--	--	--	--	S
C	Hillsborough	109	--	--	--	--	--	--	--	--	--	--
D	Hesson	110	--	--	--	--	--	--	--	--	--	--
E	Sauvie	111	--	--	--	--	--	--	--	--	--	--
F	Dollar	113	--	--	--	--	--	--	--	--	--	--
G	Sifton	115	--	--	--	--	--	--	--	--	--	--
H	Puyallup	115	--	--	--	--	--	--	--	--	--	--
I	Lauren	128	S	--	--	--	--	--	--	--	--	--
J	Wind	145	S	S	--	--	--	--	--	--	--	--

***Table 9.**--One-way analysis of variance and multiple range test among mean concentrations of metals determined by the total-recoverable method for different soil series in Clark County, Wash.*

[mg/kg, milligrams per kilogram of dry soil; S indicates a significant difference (at a 95 percent confidence level) between metals concentrations in different soil series; letter codes for the soils are arranged according to increasing mean concentrations, these codes differ for each metal; -- indicates no significant difference between metals concentrations in different soil series]

Code	Soil	Mean concentration (percent)	Variable: Aluminum A	B	C	D	E	F	G	H	I	J	K
A	Sauvie	1.86	--	--	--	--	--	--	S	S	S	S	S
B	Odne	2.44	--	--	--	--	--	--	--	S	S	S	S
C	Puyallup	2.62	--	--	--	--	--	--	--	S	S	S	S
D	Hillsborough	2.85	--	--	--	--	--	--	--	--	S	S	S
E	Gee	3.09	--	--	--	--	--	--	--	--	S	S	S
F	Wind	3.20	--	--	--	--	--	--	--	--	S	S	S
G	Dollar	3.59	S	--	--	--	--	--	--	--	--	--	S
H	Cove	4.09	S	S	S	--	--	--	--	--	--	--	--
I	Sifton	4.67	S	S	S	S	S	S	--	--	--	--	--
J	Lauren	4.74	S	S	S	S	S	S	--	--	--	--	--
K	Hesson	5.16	S	S	S	S	S	S	S	--	--	--	--

Code	Soil	Mean concentration (mg/kg)	Variable: Arsenic A	B	C	D	E	F	G	H	I	J	K
A	Sifton	2.05	--	--	--	--	--	--	--	--	S	S	S
B	Wind	2.15	--	--	--	--	--	--	--	--	--	S	S
C	Lauren	2.30	--	--	--	--	--	--	--	--	--	S	S
D	Puyallup	3.07	--	--	--	--	--	--	--	--	--	S	S
E	Hesson	3.52	--	--	--	--	--	--	--	--	--	--	S
F	Hillsborough	3.55	--	--	--	--	--	--	--	--	--	--	S
G	Sauvie	3.68	--	--	--	--	--	--	--	--	--	--	--
H	Gee	4.31	--	--	--	--	--	--	--	--	--	--	--
I	Odne	5.00	S	--	--	--	--	--	--	--	--	--	--
J	Cove	6.13	S	S	S	S	--	--	--	--	--	--	--
K	Dollar	6.41	S	S	S	S	S	S	--	--	--	--	--

***Table 9.**--One-way analysis of variance and multiple range test among mean concentrations of metals determined by the total-recoverable method for different soil series in Clark County, Wash.--Continued*

Code	Soil	Mean concentration (mg/kg)	Variable: Beryllium A	B	C	D	E	F	G	H	I	J	K
A	Puyallup	0.70	--	--	S	S	S	S	S	S	S	S	S
B	Sauvie	0.92	--	--	--	--	--	--	S	S	S	S	S
C	Hillsborough	1.29	S	--	--	--	--	--	--	--	--	--	--
D	Wind	1.29	S	--	--	--	--	--	--	--	--	--	--
E	Gee	1.33	S	--	--	--	--	--	--	--	--	--	--
F	Odne	1.45	S	--	--	--	--	--	--	--	--	--	--
G	Dollar	1.57	S	S	--	--	--	--	--	--	--	--	--
H	Lauren	1.73	S	S	--	--	--	--	--	--	--	--	--
I	Cove	1.76	S	S	--	--	--	--	--	--	--	--	--
J	Hesson	1.78	S	S	--	--	--	--	--	--	--	--	--
K	Sifton	1.86	S	S	--	--	--	--	--	--	--	--	--

Code	Soil	Mean concentration (mg/kg)	Variable: Cadmium A	B	C	D	E	F	G	H	I	J	K
A	Puyallup	0.41	--	--	--	--	--	--	--	S	S	S	S
B	Sauvie	0.74	--	--	--	--	--	--	--	--	--	--	--
C	Gee	0.75	--	--	--	--	--	--	--	--	--	--	--
D	Hillsborough	0.79	--	--	--	--	--	--	--	--	--	--	--
E	Odne	0.80	--	--	--	--	--	--	--	--	--	--	--
F	Dollar	0.82	--	--	--	--	--	--	--	--	--	--	--
G	Wind	0.87	--	--	--	--	--	--	--	--	--	--	--
H	Lauren	0.99	S	--	--	--	--	--	--	--	--	--	--
I	Cove	1.03	S	--	--	--	--	--	--	--	--	--	--
J	Hesson	1.14	S	--	--	--	--	--	--	--	--	--	--
K	Sifton	1.18	S	--	--	--	--	--	--	--	--	--	--

Table 9.--One-way analysis of variance and multiple range test among mean concentrations of metals determined by the total-recoverable method for different soil series in Clark County, Wash.--Continued

Code	Soil	Mean concentration (mg/kg)	A	B	C	D	E	F	G	H	I	J	K
						Variable: Chromium							
A	Puyallup	11.6	--	--	--	--	S	S	S	S	S	S	S
B	Wind	17.5	--	--	--	--	--	--	--	--	--	--	S
C	Lauren	18.5	--	--	--	--	--	--	--	--	--	--	S
D	Sauvie	19.8	--	--	--	--	--	--	--	--	--	--	--
E	Hillsborough	21.0	S	--	--	--	--	--	--	--	--	--	--
F	Sifton	22.4	S	--	--	--	--	--	--	--	--	--	--
G	Gee	22.5	S	--	--	--	--	--	--	--	--	--	--
H	Dollar	23.4	S	--	--	--	--	--	--	--	--	--	--
I	Cove	23.8	S	--	--	--	--	--	--	--	--	--	--
J	Odne	24.9	S	--	--	--	--	--	--	--	--	--	--
K	Hesson	27.4	S	S	S	--	--	--	--	--	--	--	--

Code	Soil	Mean concentration (percent)	A	B	C	D	E	F	G	H	I	J	K
						Variable: Iron							
A	Sauvie	2.49	--	--	--	--	--	--	S	S	S	S	S
B	Hillsborough	3.21	--	--	--	--	--	--	--	--	--	S	S
C	Gee	3.44	--	--	--	--	--	--	--	--	--	S	S
D	Puyallup	3.55	--	--	--	--	--	--	--	--	--	S	S
E	Hesson	3.68	--	--	--	--	--	--	--	--	--	--	S
F	Odne	3.74	--	--	--	--	--	--	--	--	--	--	S
G	Cove	4.36	S	--	--	--	--	--	--	--	--	--	--
H	Wind	4.41	S	--	--	--	--	--	--	--	--	--	--
I	Dollar	4.53	S	--	--	--	--	--	--	--	--	--	--
J	Sifton	5.26	S	S	S	S	--	--	--	--	--	--	--
K	Lauren	5.43	S	S	S	S	S	S	--	--	--	--	--

Table 9.--One-way analysis of variance and multiple range test among mean concentrations of metals determined by the total-recoverable method for different soil series in Clark County, Wash.--Continued

Code	Soil	Mean concentration (mg/kg)	Variable: Manganese A	B	C	D	E	F	G	H	I	J	K
A	Puyallup	330	--	--	--	--	--	--	S	S	S	S	S
B	Sauvie	447	--	--	--	--	--	--	--	--	S	S	S
C	Cove	791	--	--	--	--	--	--	--	--	--	--	S
D	Odne	808	--	--	--	--	--	--	--	--	--	--	S
E	Dollar	815	--	--	--	--	--	--	--	--	--	--	S
F	Wind	840	--	--	--	--	--	--	--	--	--	--	--
G	Lauren	936	S	--	--	--	--	--	--	--	--	--	--
H	Sifton	959	S	--	--	--	--	--	--	--	--	--	--
I	Hillsborough	1,005	S	S	--	--	--	--	--	--	--	--	--
J	Gee	1,300	S	S	--	--	--	--	--	--	--	--	--
K	Hesson	1,355	S	S	S	S	S	--	--	--	--	--	--

Code	Soil	Mean concentration (mg/kg)	Variable: Lead A	B	C	D	E	F	G	H	I	J	K
A	Puyallup	5.9	--	--	--	--	--	--	--	--	--	--	S
B	Wind	7.4	--	--	--	--	--	--	--	--	--	--	S
C	Dollar	7.4	--	--	--	--	--	--	--	--	--	--	S
D	Odne	8.6	--	--	--	--	--	--	--	--	--	--	S
E	Hillsborough	8.9	--	--	--	--	--	--	--	--	--	--	S
F	Lauren	9.3	--	--	--	--	--	--	--	--	--	--	S
G	Sauvie	9.9	--	--	--	--	--	--	--	--	--	--	S
H	Sifton	12.2	--	--	--	--	--	--	--	--	--	--	--
I	Gee	12.7	--	--	--	--	--	--	--	--	--	--	--
J	Hesson	13.7	--	--	--	--	--	--	--	--	--	--	--
K	Cove	22.0	S	S	S	S	S	S	S	--	--	--	--

Table 9.--One-way analysis of variance and multiple range test among mean concentrations of metals determined by the total-recoverable method for different soil series in Clark County, Wash.--Continued

Code	Soil	Mean concentration (mg/kg)	A	B	C	D	E	F	G	H	I	J	K
						Variable: Zinc							
A	Puyallup	43.8	--	--	--	--	S	S	S	S	S	S	S
B	Odne	64.3	--	--	--	--	--	--	--	--	--	--	--
C	Dollar	67.6	--	--	--	--	--	--	--	--	--	--	--
D	Cove	71.1	--	--	--	--	--	--	--	--	--	--	--
E	Sauvie	75.4	S	--	--	--	--	--	--	--	--	--	--
F	Hillsborough	75.4	S	--	--	--	--	--	--	--	--	--	--
G	Wind	77.6	S	--	--	--	--	--	--	--	--	--	--
H	Hesson	79.3	S	--	--	--	--	--	--	--	--	--	--
I	Gee	84.2	S	--	--	--	--	--	--	--	--	--	--
J	Lauren	91.2	S	--	--	--	--	--	--	--	--	--	--
K	Sifton	92.0	S	--	--	--	--	--	--	--	--	--	--

standard sample was obtained by determining a single value for a sample composited with materials from 5 different localities within the site.

Variance Between Depths or Horizons

Concentrations of some metals vary with depth. A Wilcoxon rank sum test was used to determine if there was a significant difference between metals concentrations in shallow and deep samples. Total concentrations of aluminum, chromium, iron, and nickel were significantly larger in deep samples than in shallow samples, whereas total concentrations of lead, manganese, and zinc were significantly larger in shallow samples than in deep samples (table 10). Similarly, total-recoverable concentrations of aluminum, chromium, and iron were significantly larger in deep samples than in shallow samples, whereas total-recoverable concentrations of lead, manganese, mercury, and zinc were significantly larger in shallow samples than in deep samples.

The accumulation of some metals at depth and others near the surface are typically controlled by soil-forming processes. For example, the eluviation of aluminum and iron from the A horizon may result in the accumulation of these metals in the B horizon. This process will vary among different locations, depending on the extent of soil profile development. In contrast, some transition metals, such as lead, manganese, and zinc, commonly accumulate near the surface because they are retained by various soil processes (that is, nutrient cycling, sorption to inorganic substances, and chelating of metals by organic compounds). However, other transition metals such as chromium may not necessarily accumulate near the surface, but may be leached from the A horizon. Under oxidizing conditions, available chromium will form chromate, which is highly soluble (Kabata-Pendias and Pendias, 1984). Chromate will migrate downward in the soil until conditions become more reducing, at which time chromate will reduced and be strongly absorbed to soil particles.

Correlation Matrices

Non-parametric correlation matrices were constructed to examine relations among the total metals concentrations (table 11), between total metals concentrations and other soil properties (table 12), among the total-recoverable metals concentrations (table 13), and between total-recoverable metals concentrations and other soil properties (table 14). The significant relations observed are described below for each metal.

Aluminum: Total concentrations of aluminum increased with increased concentrations of copper, iron, and CEC and decreased with increased concentrations of lead, silt, and clay. Total-recoverable concentrations of aluminum increased with increased concentrations of beryllium, cadmium, chromium, copper, iron, manganese, zinc, organic carbon, and CEC and decreased with increased concentrations of mercury and clay.

Arsenic: Total-recoverable concentrations of arsenic increased with increased concentrations of cadmium, chromium, copper, lead, organic carbon, silt, and clay and decreased with increased concentrations of sand.

Beryllium: Total concentrations of beryllium decreased with increased concentrations of copper, organic carbon, and CEC. Total-recoverable concentrations of beryllium increased with increased concentrations of aluminum, cadmium, chromium, iron, manganese, zinc, organic carbon, and CEC and decreased with increased concentrations of mercury and clay.

Cadmium: Total-recoverable concentrations of cadmium increased with increased concentrations of aluminum, arsenic, beryllium, chromium, copper, iron, manganese, lead, zinc, organic carbon, and CEC and decreased with increased concentrations of clay.

Chromium: Total concentrations of chromium increased with increased concentrations of nickel and decreased with increased concentrations of organic carbon. Total-recoverable concentrations of chromium increased with increased concentrations of aluminum, arsenic, beryllium, cadmium, iron, lead, nickel, and silt and decreased with increased concentrations of organic carbon.

Copper: Total concentrations of copper increased with increased concentrations of aluminum and iron and decreased with increased concentrations of beryllium, silt, and clay. Total-recoverable concentrations of copper increased with increased concentrations of aluminum, arsenic, cadmium, iron, and CEC.

Iron: Total concentrations of iron increased with increased concentrations of aluminum, copper, nickel, and zinc and decreased with increased concentrations of silt and clay. Total-recoverable concentrations of iron increased with increased concentrations of aluminum, beryllium, cadmium, chromium, copper, manganese, zinc, CEC, and sand and decreased with increased concentrations of mercury and clay.

***Table 10.**--Wilcoxon Signed Ranks test comparing the difference between concentrations of metals, determined by the total and the total-recoverable methods, at shallow and deep sampling depths in Clark County, Wash.*

[Ho, null hypothesis; Ha, alternative hypothesis; FTR, failure to reject null hypothesis at a 95 percent confidence level; Deep ≥ shallow, the mean concentration of the metal in deep samples is greater than or equal to the mean concentration in shallow samples; Deep not ≥ shallow, the mean concentration of the metal in deep samples is not greater than or equal to the mean concentration in shallow samples; (p=0.016), the probability of falsely rejecting a true null hypothesis; --, could not determine]

	Total method			Total-recoverable method		
Metal	Ho	Ha	Result	Ho	Ha	Result
Aluminum	Deep ≤ shallow	Deep not ≤ shallow	Reject (p=0.0001)	Deep ≤ shallow	Deep not ≤ shallow	Reject (p=0.048)
Arsenic	--	--	--	Deep = shallow	Deep not = shallow	FTR (p=0.22)
Beryllium	--	--	--	Deep = shallow	Deep not = shallow	FTR (p=0.49)
Cadmium	--	--	--	Deep = shallow	Deep not = shallow	FTR (p=0.15)
Chromium	Deep ≤ shallow	Deep not ≤ shallow	Reject (p=0.002)	Deep ≤ shallow	Deep not ≤ shallow	Reject (p=0.019)
Copper	Deep = shallow	Deep not = shallow	FTR (p=0.11)	Deep = shallow	Deep not = shallow	FTR (p=0.15)
Iron	Deep ≤ shallow	Deep not ≤ shallow	Reject (p=0.0001)	Deep ≤ shallow	Deep not ≤ shallow	Reject (p=0.066)
Mercury	--	--	--	Deep ≥ shallow	Deep not ≥ shallow	Reject (p=0.002)
Manganese	Deep ≥ shallow	Deep not ≥ shallow	Reject (p=0.0011)	Deep ≥ shallow	Deep not ≥ shallow	Reject (p=0.004)
Nickel	Deep ≤ shallow	Deep not ≤ shallow	Reject (p=0.019)	Deep = shallow	Deep not = shallow	FTR (p=0.35)
Lead	Deep ≥ shallow	Deep not ≥ shallow	Reject (p=0.0002)	Deep ≥ shallow	Deep not ≥ shallow	Reject (p=0.0003)
Zinc	Deep ≥ shallow	Deep not ≥ shallow	Reject (p=0.0002)	Deep ≥ shallow	Deep not ≥ shallow	Reject (p=0.0001)

Table 11.--Correlation coefficients among concentrations of selected metals determined by the total method for soils sampled in Clark County, Wash.

[Underlined values demonstrate a significant correlation at a 95-percent confidence level]

Metal	Spearman ranked correlation coefficients, in percent								
	Aluminum	Beryllium	Chromium	Copper	Iron	Manganese	Nickel	Lead	Zinc
Aluminum	100	-22	-24	63	71	-5	-8	-40	-4
Beryllium		100	15	-39	2	-10	13	-10	3
Chromium			100	-19	15	1	87	14	10
Copper				100	34	-15	-4	-17	-19
Iron					100	21	33	-6	32
Manganese						100	11	25	65
Nickel							100	22	25
Lead								100	37
Zinc									100

Table 12.--Correlation coefficients between concentrations of selected metals determined by the total method and organic carbon concentration, cation exchange capacity, and amount of silt and clay for soils sampled in Clark County, Wash.

[Underlined values demonstrate a significant correlation at a 95-percent confidence level]

Metal	Spearman ranked correlation coefficient, in percent			
	Organic carbon	Cation exchange capacity	Silt	Clay
Aluminum	15	28	-44	-62
Beryllium	-59	-42	17	26
Chromium	-45	-38	21	25
Copper	21	27	-29	-35
Iron	0	34	-34	-48
Manganese	49	16	-29	-9
Nickel	-40	-21	5	17
Lead	22	40	9	22
Zinc	26	16	-18	-3

Table 13.--Correlation coefficients among concentrations of selected metals determined by the total-recoverable method for soils sampled in Clark County, Wash.

[Underlined values demonstrate a significant correlation at a 95-percent confidence level]

	Spearman ranked correlation coefficient, in percent											
Metal	Aluminum	Arsenic	Beryllium	Cadmium	Chromium	Copper	Iron	Mercury	Manganese	Nickel	Lead	Zinc
Aluminum	100	2	76	51	28	35	83	-32	50	5	22	31
Arsenic		100	21	25	51	25	13	19	21	4	29	8
Beryllium			100	67	35	23	79	-28	63	2	22	30
Cadmium				100	24	28	49	-12	46	20	36	53
Chromium					100	22	28	10	13	52	24	4
Copper						100	25	6	-11	22	17	8
Iron							100	-39	48	1	1	24
Mercury								100	-14	16	30	9
Manganese									100	-14	32	46
Nickel										100	29	36
Lead											100	63
Zinc												100

Table 14.--Correlation coefficients between concentrations of selected metals determined by the total-recoverable method and organic carbon concentration, cation exchange capacity, and amount of sand, silt, and clay for soils sampled in Clark County, Wash.

[Underlined values demonstrate a significant correlation of a 95-percent confidence level]

	Spearman ranked correlation coefficient, in percent				
Metal	Organic carbon	Cation exchange capacity	Sand	Silt	Clay
Aluminum	33	62	22	-21	-55
Arsenic	28	6	-34	57	36
Beryllium	37	58	6	-10	-43
Cadmium	41	55	-9	-6	-24
Chromium	-34	20	-22	44	19
Copper	18	47	-9	0	-6
Iron	25	61	23	-21	-52
Mercury	17	26	-35	29	36
Manganese	41	31	7	1	-24
Nickel	-27	31	-30	25	29
Lead	31	46	-36	32	26
Zinc	27	50	-28	11	8

Mercury: Total-recoverable concentrations of mercury increased with increased concentrations of lead, silt, and clay and decreased with increased concentrations of aluminum, beryllium, iron, and sand.

Manganese: Total concentrations of manganese increased with increased concentrations of zinc and organic carbon and decreased with increased concentrations of silt. Total-recoverable concentrations of manganese increased with increased concentrations of aluminum, beryllium, cadmium, iron, lead, zinc, and organic carbon and decreased with increased concentrations of clay.

Nickel: Total concentrations of nickel increased with increased concentrations of chromium and iron and decreased with increased concentrations of organic carbon. Total-recoverable concentrations of nickel increased with increased concentrations of chromium, lead, zinc, silt, and clay and decreased with increased concentrations of organic carbon and sand.

Lead: Total concentrations of lead increased with increased concentrations of zinc, and CEC and decreased with increased concentrations of aluminum. Total-recoverable concentrations of lead increased with increased concentrations of arsenic, cadmium, chromium, mercury, manganese, nickel, zinc, organic carbon, CEC, silt, and clay and decreased with increased concentrations of sand.

Zinc: Total concentrations of zinc increased with increased concentrations of iron, lead, and manganese. Total-recoverable concentrations of zinc increased with increased concentrations of aluminum, beryllium, cadmium, iron, lead, manganese, nickel, organic carbon, and CEC and decreased with increased concentrations of sand.

Four groups of metals that were significantly correlated to organic carbon or particle size were identified. Group 1 consisted of beryllium, chromium, and nickel determined by the total method; increased concentrations of each were associated with decreased concentrations of organic carbon. Group 2 consisted of aluminum, copper, and iron determined by the total method; increased concentrations of each were associated with decreased concentrations of clay. Group 3 consisted of aluminum, beryllium, cadmium, manganese, and zinc determined by the total-recoverable method; increased concentrations of all were associated with increased organic carbon concentrations, and all but zinc decreased with concentrations of clay. Group 4 consisted of arsenic, lead, mercury, and nickel determined by the total-recoverable method; increased concentrations of each were associated with increased concentrations of clay. However, the correlation between mercury and clay was strongly influenced by a single outlying value. A strong positive correlation of organic carbon content with CEC and the lack of any significant correlation of clay content with CEC suggested that the CEC in the soils was more strongly related to organic matter than clay minerals.

AREAL TRENDS AND ESTABLISHING BASELINE METALS CONCENTRATIONS FOR SOILS IN CLARK COUNTY

Areal trends in the data demonstrate relations between total-recoverable metals concentrations and the physiographic regions of Clark County. For example, total-recoverable concentrations of aluminum and copper determined for samples collected at sites located in the southern one-half of the Fourth Plains and Terraces area are distinctly larger than concentrations determined for samples collected at sites located in the northern one-half of the Fourth Plains and Terraces area (figures 4 and 5). Concentrations of total-recoverable aluminum were generally lowest along the Lowland Valley Area and highest along the Troutdale Bench; no additional trends were observed for copper. Principal components analysis showed that different soil series could be placed into one of five dissimilar factor groups, which apparently correspond to the 5 physiographic regions in the study area. Multiple discriminant analysis showed that the different factor groups could be distinguished from one another based on the total-recoverable metals concentrations, and thus the 5 factor groups were distinct and represented the 5 physiographic regions. Finally, the magnitude and variability of metals concentrations in soils in Clark County may be used to establish baseline values indicative of naturally occurring metals concentrations in soils; for most total-recoverable metals, the estimated 90th percentile was significantly larger than the estimated true median and, as a result, the number of samples collected was adequate to characterize total-recoverable baseline concentrations.

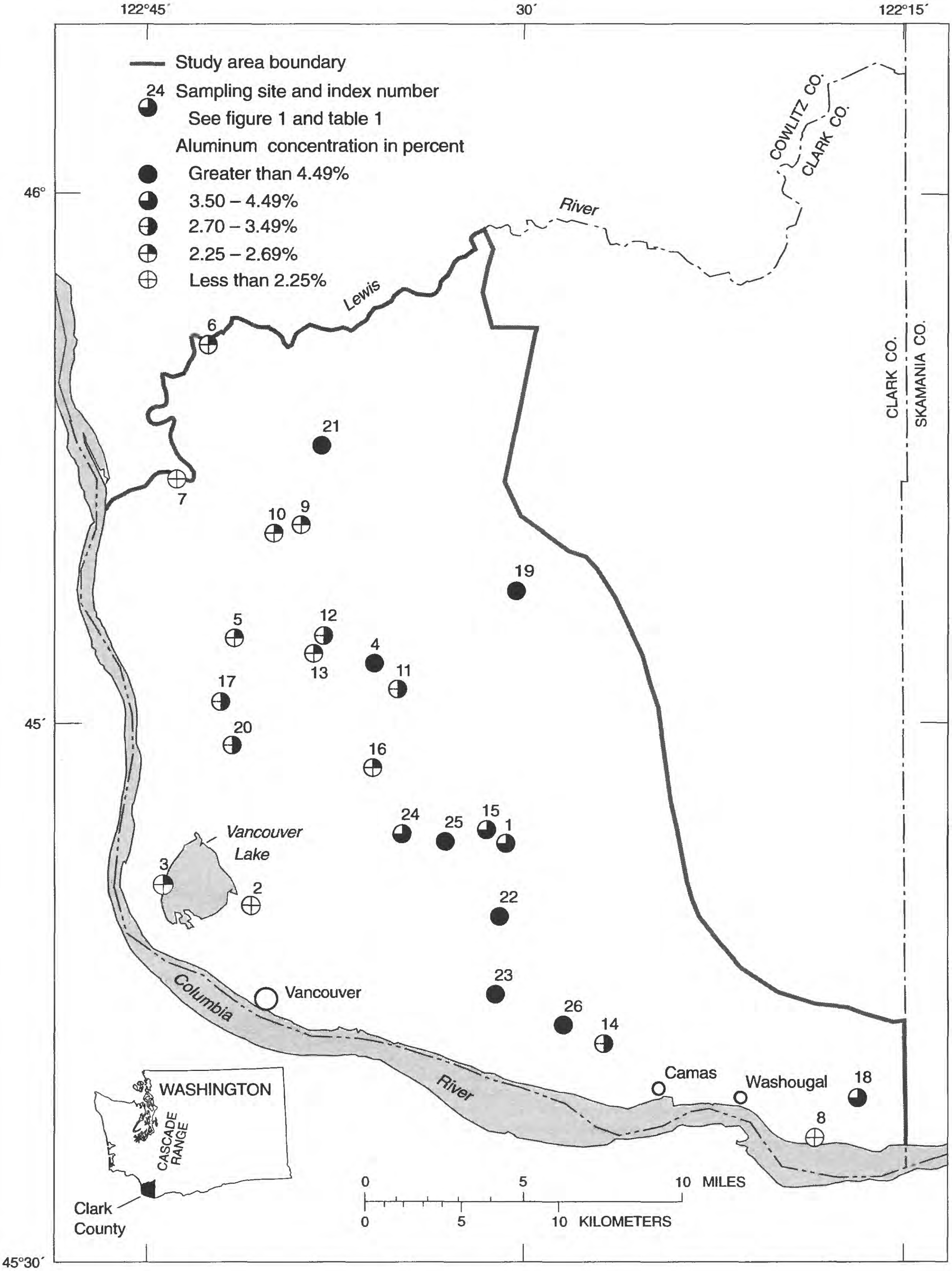

Figure 4. Total-recoverable aluminum concentrations of soils in Clark County, Wash.

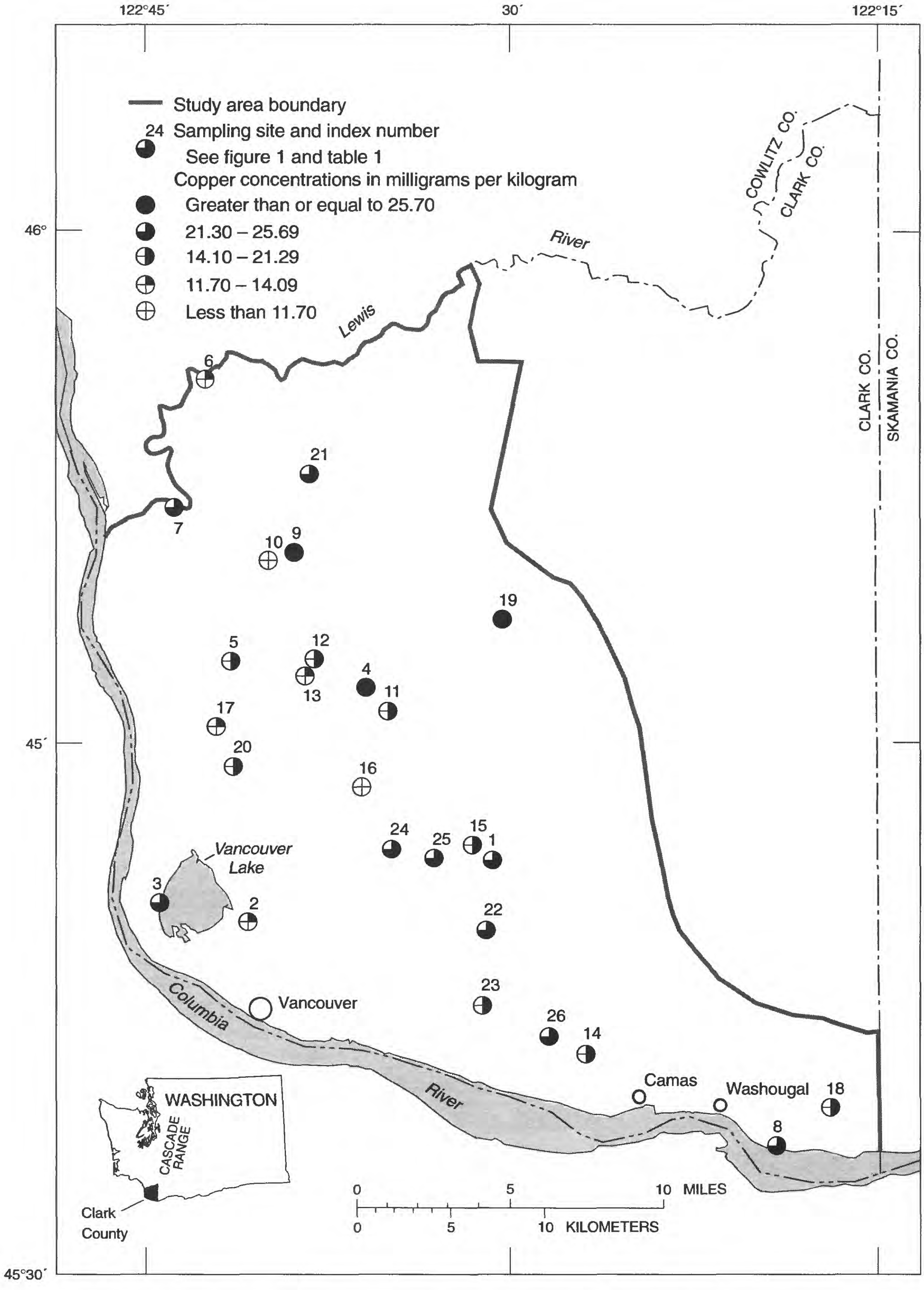

Figure 5. Total-recoverable copper concentrations of soils in Clark County, Wash.

Principal Components Analysis

Principal components analysis was used to examine the correlations among the total and total-recoverable metals concentrations to determine if different metals behave as a group (tables 15 and 16). This method, described by Davis (1986) and Johnson and Wichern (1982), involves finding the eigenvalues and eigenvectors of the parametric correlation matrix. A useful result of such an analysis is that the dimensionality of the matrix can often be reduced. Thus, by constructing linear combinations of the variables, a new, smaller set of variables (the eigenvectors) is produced, which accounts for most of the variance of the original variables. The quantity of those new variables in the samples was calculated and their spatial distribution studied. To aid interpretation of the principal components, they were rotated to maximum variance positions (Varimax rotation). Following common usage, these varimax-rotated components are now called factors. In this way, the dimensionality was reduced, and possibly greater insight to the mutual behavior of the different metals was obtained. These factors are orthogonal, meaning that they are mathematically uncorrelated. In principle, these factors represent assemblages of metals that behave as a group either because of similar chemistry or in response to some common cause. The problem is to attach chemical or physical meaning to these factors.

Factors--Total Metals

Five factors accounted for 72.8 percent of the total metals concentrations variance (table 15). The communality term shown is a measure of the quantity of the overall variance of a metal that was accounted for by the different factors. Communalities ranged from 90 percent for aluminum to 99 percent for calcium.

Factor 1, which included cobalt, iron, scandium, titanium, vanadium, and yttrium, was composed of transitions metals. Likewise, factors 2 and 4, which included copper and titanium, and chromium and nickel, respectively, were composed of transition metals. In aerobic soils, the differences in the behavior of various transition metals is very subtle, and they tend to accumulate in the upper soil horizon (Bohn and others, 1985). Therefore, these three factors were combined into one transition metals factor, thereby further reducing the dimensionality in the data and accounting for 45.2 percent of the variance.

Factor 3 accounted for 14.6 percent of the total variance and consisted exclusively of the alkali and alkali earth metals calcium, magnesium, sodium, and strontium. These metals occur primarily as exchangeable cations in most soils. Other alkali and alkali earths were loaded onto the transition metals factors, but did not account for large amounts of variance in each of those factors.

Factor 5 accounted for 13 percent of the total variance and consisted exclusively of the lanthanides cesium, lanthanum, neodymium. Lanthanides were not loaded onto any other factors, and apparently their occurrence was independent from the occurrence of other metals.

Factors--Total-Recoverable Metals

Five factors accounted for 78.8 percent of the total-recoverable metals concentrations variance (table 16). Communalities ranged from a low of 68 percent for mercury to a high of 92 percent for copper. Factor 1 consisted of copper and manganese; however, the correlation between these two metals was not significant. Manganese was loaded on all five factors to varying degrees and, therefore, apparently did not reflect a unique assemblage or causative association.

Factor 2, which consisted of aluminum, beryllium, cadmium, iron, mercury, and zinc, was similar to the grouping of metals that were significantly correlated with organic carbon (group 3, discussed in the previous section).

Factor 3 consisted of arsenic and chromium. Although total-recoverable concentrations of arsenic increased with increased concentrations of organic carbon and clay and concentrations of chromium did not, there was a significant correlation between these two metals. It was difficult, therefore, to identify this factor with a specific physical or chemical association.

Factor 4 consisted of lead, mercury, and zinc. Both mercury and zinc also were loaded on Factor 2. This suggests that part of the zinc variance was associated with the organic carbon factor and part was associated with lead. The association between mercury and both of these factors was suspect because the overall variability in mercury was small, probably close to random oscillations near laboratory minimum reporting levels. Yet the principal components analysis apportioned the variance of a metal over the different factors; thus mercury was assigned to two factors, but its association here probably was not significant.

Table 15.--Principal components analysis for metals concentrations determined by the total method for soils sampled in Clark County, Wash.

[Com, communality in percent; only those loading greater than 50 percent of the total variance associated with a factor are shown; --, no data shown]

Factors/Eigenvalues (in percent)											
1 27.3		2 8.0		3 14.6		4 9.9		5 13.0		Total 72.8	
Metal	Com	Metal	Com	Metal	Com	Metal	Com	Metal	Com	Metal	Total com
Sc	95	Cu	83	Sr	94	Ni	90	Nd	89	Al	90
Fe	95	Ba	56	Ca	93	Cr	87	La	85	Ba	97
U	91	Ti	50	Na	85	Li	58	Ce	85	Ca	99
Al	87	--	--	Mg	81	--	--	--	--	Ce	94
Y	80	--	--	--	--	--	--	--	--	Co	97
Co	77	--	--	--	--	--	--	--	--	Cr	96
Ti	71	--	--	--	--	--	--	--	--	Cu	98
K	71	--	--	--	--	--	--	--	--	Fe	97
--	--	--	--	--	--	--	--	--	--	K	93
--	--	--	--	--	--	--	--	--	--	La	97
--	--	--	--	--	--	--	--	--	--	Li	94
--	--	--	--	--	--	--	--	--	--	Mg	93
--	--	--	--	--	--	--	--	--	--	Na	98
--	--	--	--	--	--	--	--	--	--	Nd	96
--	--	--	--	--	--	--	--	--	--	Ni	96
--	--	--	--	--	--	--	--	--	--	Sc	98
--	--	--	--	--	--	--	--	--	--	Sr	98
--	--	--	--	--	--	--	--	--	--	Ti	95
--	--	--	--	--	--	--	--	--	--	U	97
--	--	--	--	--	--	--	--	--	--	Y	97

Table 16.--Principal components analysis for metals concentrations determined by the total-recoverable method for soils sampled in Clark County, Wash.

[Table shows the eigenvalues of the Varimax matrix, the communality (Com) of the variables and the variables loaded on the five varimax factors. Only those loadings greater than 15 percent of total variance associated with a factor are shown; --, no data shown]

Factors/Eigenvalues (in percent)											
1 9.9		2 28.2		3 14.1		4 13.7		5 12.8		Total 78.8	
Metal	Com	Metal	Com	Metal	Com	Metal	Com	Metal	Com	Metal	Total Com
Cu	87	Al	73	As	85	Pb	69	Ni	91	As	86
Mn	17	Be	71	Cr	51	Zn	37	Mn	40	Be	88
--	--	Fe	65	--	--	Hg	31	--	--	Cd	74
--	--	Cd	61	--	--	--	--	--	--	Cr	70
--	--	Hg	22	--	--	--	--	--	--	Cu	92
--	--	Zn	18	--	--	--	--	--	--	Pb	72
										Mn	78
										Ni	91
										Zn	73
										Al	82
										Fe	72
										Hg	68

Factor 5 consisted of manganese and nickel, both transition metals. Although total-recoverable concentrations of nickel increased with increased concentrations of clay and decreased with increased concentrations of organic carbon, whereas the opposite was observed for total-recoverable concentrations of manganese, there was a significant correlation between these two metals.

Median Factor Scores

The median factor scores for each soil series were calculated to determine if soils series with similar scores could be grouped together. The median factor scores for the total metals concentrations (table 17) showed no apparent trends among the various soil series. However, the median factor scores for the total-recoverable metals concentrations (fig. 6; table 18) showed that different soil series could be placed into one of five dissimilar factor groups. Group 1 consisted of the Sauvie soil series and included sites 3, 7, and 8, at which soils developed in recent alluvium deposited from the Columbia River. Group 2 consisted of the Lauren, Wind River, Cove, and Sifton soil series, located in the southern one-third of the Fourth Plains and Terraces area, and included sites 1, 2, 14, 22, 23, 25, and 26. Soils at these sites were formed primarily in Pleistocene coarse-grained deltaic sediments. Group 3 consisted of the Dollar, Gee, Hillsboro, Odne, and Wind River soil series, located in the northern two-thirds of the Fourth Plains and Terraces area, and included sites 4, 5, 10, 11, 12, 13, 16, 17, 20, and 24. Soils at these sites developed in finer grained Pleistocene deltaic sediments. Group 4 consisted of the Puyallup and Hesson soil series, located on or near the Troutdale Bench, and included sites 6, 9, 18, and 21. Finally, group 5 consisted solely of the samples collected from the Cove soil series at site 19, which also was located on the Troutdale Bench but the soils developed in outcrops of Boring lavas. Thus, these groupings were apparently related to the physiographic areas presented by Mundorff (1964) and the geology of Clark County described by Phillips (1987) and Trimble (1963).

Multiple Discriminant Analysis

Multiple discriminant analysis (MDA) was used to determine if the different factor groups could be distinguished from one another based on the total-recoverable metals concentrations. This technique (described by Davis, 1986), which can be thought of as related to multiple regression, was used to find the best linear discriminant between the different groups. The function derived attempted to maximize the between-group variance and minimize the within-group variance. As with step-wise multiple regression, the best subset of variables

Table 17.*--Median values of five factors for total metals concentrations for different soil series in Clark County, Wash.*

Soil series	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Lauren	-1.54	-0.02	-0.05	0.83	0.43
Dollar	-0.19	0.43	-0.66	-0.37	-0.72
Gee	0.77	0.55	-0.31	0.49	0.6
Sauvie	0.20	-0.03	1.63	0.06	-0.1
Puyallup	-0.13	-2.77	0.29	-0.58	-0.39
Hillsboro	0.70	0.27	-0.27	-0.22	0.28
Hesson	1.2	-0.1	-0.58	-1.1	0.53
Cove	0.17	-1.3	-1.6	0.32	-0.7
Wind River	-1.9	0.85	0.54	-0.43	-0.25

Factor 1, transition metals that include cobalt, iron, scandium, titanium, vanadium, and yttrium.

Factor 2, transition metals that include copper and titanium.

Factor 3, alkali and alkali-earth metals that include calcium, magnesium, sodium, and strontium.

Factor 4, transition metals that include chromium and nickel.

Factor 5, lanthanides that include cesium, lanthanum, and neodymium.

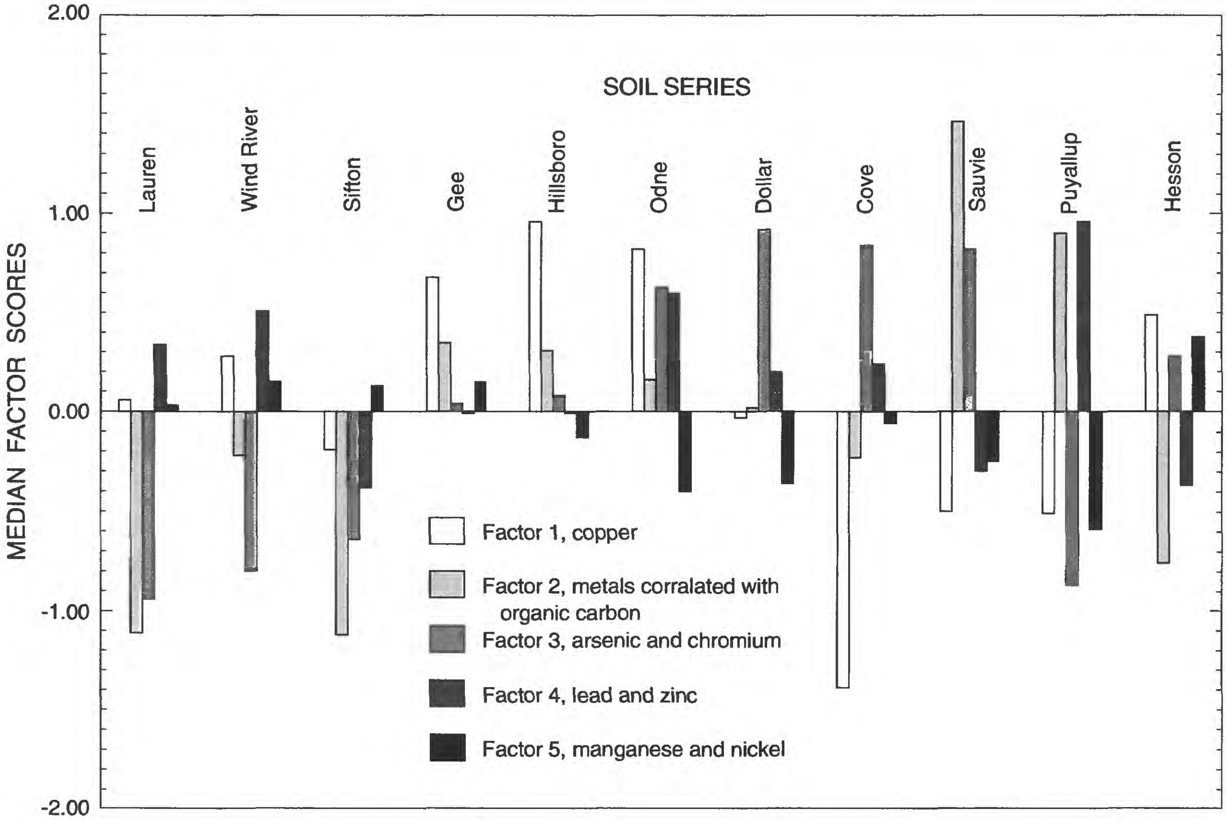

Figure 6. Median values of five factor scores for total-recoverable metals concentrations for different soil series in Clark County, Wash.

Table 18.--Median values of five factors for total-recoverable metals concentrations for different soil series in Clark County, Wash.

Soil series	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Lauren	0.06	-1.11	-0.94	0.34	0.03
Wind River	0.28	-0.22	-0.8	0.51	0.15
Sifton	-0.19	-1.12	-0.64	-0.38	0.13
Gee	0.68	0.35	0.04	-0.01	0.15
Hillsboro	0.96	0.31	0.08	-0.01	-0.13
Odne	0.82	0.16	0.63	0.60	-0.40
Dollar	-0.03	0.02	0.92	0.20	-0.36
Cove	-1.39	-0.23	0.84	0.24	-0.06
Sauvie	-0.50	1.46	0.82	-0.30	-0.25
Puyallup	-0.51	0.90	-0.87	0.96	-0.59
Hesson	0.49	-0.76	0.28	-0.37	0.38

Factor 1, copper.
Factor 2, metals correlated with organic carbon that include aluminum, beryllium, cadmium, iron, mercury, and zinc.
Factor 3, arsenic and chromium.
Factor 4, lead and zinc.
Factor 5, manganese and nickel.

that accounted for most of the variance of the system was selected, in anticipation that linear functions consisting of a reduced set of variables could be found that would discriminate among the different sites.

On the basis of the median factor scores, it was assumed that the five factor groups correspond to five geologic units (described by Phillips, 1987), which are related to the four physiographic areas in Clark County (described by Mundorff, 1964). These geologic units include recent alluvium deposited in the lowland area (Qal); gravel-sized flood deposits in the southern one-third of the Fourth Plains and Terraces area (Qg); sand-sized flood deposits in the northern two-thirds of the Fourth Plains and Terraces area (Qs); Troutdale Formation on or near the Troutdale Bench (QTtd); and Boring lavas (Qvbg) (Mundorff, 1964; Phillips, 1987). Using MDA, most samples (69 of 79) were correctly classified into their respective predicted factor groups (table 19). The five groups discussed in the preceding section were distinct and represented the different geologic units. As a result, total-recoverable metals concentrations in this area of Clark County could be predicted with fairly good accuracy based solely on information about the geologic unit from which a specific soil was derived. Therefore, it may be reasonable to divide this study area into five sub-regions (1, 2, 3, 4, and 5) based on these groups.

Although total-recoverable concentrations of 11 different metals were used for MDA, some were better discriminants than others and, as a result, were more heavily weighed during the analysis. The most significant discriminant was copper, followed by manganese, aluminum, arsenic, and zinc. Thus, within a sub-region the total-recoverable concentrations of these five metals can be predicted fairly accurately, and, depending on the nature of the investigation, it may not be necessary to analyze for a large array of metals.

Use in Evaluation of Potentially Contaminated Sites

The magnitude and variability of metals concentrations in soils in Clark County may be used to establish baseline values indicative of naturally occurring metals concentrations in soils. In most investigations and applications, baseline values generally encompass 90 to 95 percent of all observations. For example, the estimated 90th percentile of total-recoverable metals concentrations in "background measurements" was used by Ecology to determine background cleanup standards for contaminated soils (Hardin and Gilbert, 1993). Other investigators not concerned with the regulatory applications of the data also have used similar ranges to define baseline. The most

Table 19.--Multiple discriminant analysis of total-recoverable metals concentrations for five factor groups in Clark County, Wash.

[Number of samples in original factor groups; Qal, recent alluvium, lowland valley area; Qg, gravel-sized flood deposits, southern one-third of the Fourth Plains and Terraces area; Qs, sand-sized flood deposits, northern two-thirds of the Fourth Plains and Terraces area; QTtd, Troutdale formation on or near the Troutdale bench; Qvbg, outcrop of Boring lavas]

	Classification				
	Geologic Units[1]				
Factor groups	Qal	Qg	Qs	QTtd	Qvbg
1	14	1	1	0	0
2	0	17	0	0	0
3	2	0	27	2	0
4	1	2	0	4	1
5	0	0	0	0	7

Metal	Multivariate F	Multivariate p
Al	10.78	0.0000
As	10.07	0.0000
Be	2.72	0.037
Cd	5.58	0.001
Cr	2.77	0.035
Cu	46.17	0.0000
Fe	4.18	0.005
Mn	12.64	0.0000
Ni[a]	0.50	0.7354
Pb	1.26	0.296
Zn	6.93	0.000

[a] Ni was withdrawn from analysis

[1] Geologic units described by Phillips (1987).

common has been the central 95 percent of the observed concentrations (approximately ± 2 standard deviations), above and below which values were considered to be outliers not characteristic of naturally occurring metals concentrations in the soils (Gough and others, 1985; Severson and Gough, 1983; Severson and Wilson, 1990; Tidball and Ebens, 1976; among others).

To substantiate baseline values for specific sets of data, some investigators (Ebens and McNeal, 1976; Severson and Wilson, 1990; among others) also have used the iterative process described by Zar (1984) to determine the minimum number of samples required to state that the true means (or medians) were less than the baseline values given. Similar calculations were made using total-recoverable metals concentrations for sub-regions 1, 2, 3, and 4 (table 20). For most metals, the estimated 90th percentile was significantly larger than the true median, and the number of samples collected was adequate to characterize total-recoverable baseline concentrations. Exceptions included iron and nickel in sub-region 1; aluminum, beryllium, cadmium, copper, and manganese in sub-region 2; nickel in sub-region 3; and beryllium, lead, mercury, nickel, and zinc in sub-region 4. For these metals a greater number of samples was needed to establish defensible baseline values.

SUMMARY AND CONCLUSIONS

This report presents data on the magnitude and variability of metals concentrations in soils in Clark County. A total of 79 samples were collected from 26 sites that were relatively unaffected by human activity. At 24 sites, one standard shallow sample and one standard deep sample were collected. At two other sites, clusters of four deep and four shallow samples were collected. Also, at three sites samples from five different depths were collected. The soil samples were analyzed to determine metals concentrations and other chemical and physical characteristics.

Table 20.--Number of samples required to determine baseline concentration of metals in soils determined by the total-recoverable method for four subregions in Clark County, Wash.

[Nr, number of samples required to determine if the 90th percentile, calculated for this sample set, is significantly greater than the true median, at a 95-percent confidence level; Ns, number of samples collected; method used is described by Zar (1984)]

Subregion 1			Subregion 2		
Metal	Nr	Ns	Metal	Nr	Ns
Fe[1]	18	17	As	4	14
Al	8	17	Be[1]	31	14
Zn	5	17	Cd[1]	39	14
Ni[1]	30	17	Cr	7	14
Mn	11	17	Cu[1]	30	14
Pb	5	17	Pb	5	14
Cu	12	17	Mn[1]	17	14
Cr	13	17	Ni	9	14
Cd	4	17	Zn	13	14
As	6	17	Al[1]	50	14
Be	7	17	Fe	9	14
			Hg	6	14

Subregion 3			Subregion 4		
Metal	Nr	Ns	Metal	Nr	Ns
As	6	31	As	6	8
Be	7	31	Be[1]	14	8
Cd	9	31	Cr	7	8
Cr	6	31	Cu	4	8
Cu	5	31	Pb[1]	31	8
Pb	7	31	Mn	6	8
Mn	8	31	Ni	22	8
Ni[1]	163	31	Zn[1]	18	8
Zn	13	31	Al	7	8
Al	8	31	Fe	5	8
Fe	5	31	Hg[1]	10	8
Hg	11	31			

[1] Ns < Nr

Concentrations of metals in the soil samples were determined by as many as four methods: total, total-recoverable, ASTM, and TCLP. The total method used strong acids to dissolve at least 95 percent of the sample. The total-recoverable method also used strong acids, but less than 95 percent of the sample material was dissolved. The ASTM and TCLP methods were used to simulate the leaching of metals in soils under contaminated conditions.

The concentrations of metals observed in Clark County fell within the range of those given by various investigators for the conterminous United States. However, the mean concentrations of many metals in soils within Clark County were considerably different from mean values presented for the conterminous United States by other investigators. For example, arithmetic mean concentrations of total arsenic, chromium, copper, nickel, vanadium, and zinc in Clark County were 10, 60, 37, 24, 179, and 112 mg/kg, respectively, compared to values of 5.2, 37, 17, 13, 58, and 48 mg/kg, respectively for the conterminous United States given by other investigators. Therefore, concentrations of metals in soils determined by various investigators for other areas of the United States were not representative of soils metals concentrations in Clark County.

The population distributions of most metals could not be determined from the samples collected.

Some individual sources of variance, including soils series and depth, were identified and estimated. Results from a one-way analysis of variance showed that total and total-recoverable metals concentrations were significantly different between different soil series. Concentrations of some metals also varied with depth. As a result, it may be necessary to consider from what soil series and at what depth a sample was collected when total-recoverable concentrations of specific metals within Clark County are being characterized.

A Wilcoxon Rank Sum test showed that total and total-recoverable concentrations of lead, manganese, mercury, and zinc were significantly larger in shallow samples than in deep samples. Concentrations of aluminum, chromium, and iron were significantly larger in deep samples than in shallow samples. The relatively larger concentrations of these metals at different depths were primarily controlled by soil formation processes. As a result, concentrations of these metals would exhibit greater variability in the older, more highly weathered soils within Clark County than in younger, less weathered soils.

Numerous significant correlations existed among metals concentrations. In addition, many metals were placed into one of four groups based on their correlations with concentrations of organic carbon or particle size distribution. The concentrations of metals in Group 1 increased significantly with decreased concentrations of organic carbon, whereas the concentrations of metals in Group 3 increased significantly with increased concentrations of organic carbon.

Principal components analysis was used to produce smaller sets of variables that accounted for most of the variance of the original variables. Five factors (sets of variables) accounted for 72.8 percent of the variance for total metals concentrations, and 5 other factors accounted for 78.8 percent of the variance for total-recoverable metals concentrations. Median factor scores were calculated for soil series, and series with similar scores were grouped together when possible. Median factor scores of the total metals concentrations showed no apparent trends among the soil series. In contrast, total-recoverable metals concentrations could be placed into five fairly distinct groups. The areal extents of these five groups were similar to the different physiographic areas within Clark County, and thus may be used to define homogenous areas.

Multiple Discriminate Analysis was used to determine if these different factor groups could be distinguished from one another based solely on the total-recoverable metals concentrations. Most samples were correctly classified into their respective groups; therefore, the five factor groups were distinct and apparently represented homogeneous sets of data. As a result, the study area may be divided into five apparently homogeneous sub-regions, which are associated with the surficial geology.

The magnitude and variability of metals concentrations in soils within Clark County can be used by Ecology to establish background cleanup standards. In most cases, the estimated 90th percentile of total-recoverable metals concentrations were significantly larger than the true medians, and the number of samples collected was adequate to characterize total-recoverable baseline concentrations for most metals.

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Table A1.--Concentrations of metals in soil samples analyzed by the total method in Clark County, Wash.

[Concentrations are in milligrams per kilogram (mg/kg) of dry soil except Al, Ca, Fe, K, Mg, Na, P, and T, which are given in percent; < indicates a value less than the laboratory's minimum reporting value]

Sample number	Aluminum (percent)	Calcium (percent)	Iron (percent)	Potassium (percent)
G10.3	9.5	1.1	8.4	1
G12.5	10	1	8.8	0.9
G40.3	9.2	0.9	5.9	1.1
G42.5	9.2	0.9	5.8	1.2
G50.3	7.5	0.9	4.4	1.8
G52.5	7.7	0.8	5.4	1.7
G70.3	8.4	2.8	4	1
G72.2	8.9	3	3.7	1.1
G80.3 B	7.4	2.3	4.9	1.7
G80.3 D	7.4	2.2	4.4	1.5
G80.3 V	7.2	2.3	4.6	1.5
G80.8 V	7.5	2.6	5.2	1.6
G81.4 V	7.8	2.3	5.5	1.6
G82.2 B	7.6	2.4	4.7	1.6
G82.2 D	7.6	2.4	4.3	1.7
G82.2 V	7.6	2.5	4.6	1.5
G83.0 V	7.4	2.6	4.3	1.6
G90.3	8.6	1.7	5.7	1
G92.2	8.8	1.5	6.1	1.1
G110.3	7.8	1.1	4.9	1.4
G112.2	8.6	0.8	6	1.4
G120.3	6.8	0.9	4.1	1.4
G122.2	8.3	0.7	5.3	1.4
G150.3	9.6	0.7	5.7	0.9
G152.2	9.2	0.9	5.9	1.0
G160.3	7.4	1.1	5.1	1.3
G162.2	8.4	0.8	6.7	1.2
G170.3	7	1.1	4	1.6
G172.2	7.6	0.9	4.7	1.3
G180.3	7.3	0.9	4.5	1.3
G182.2	8.2	0.7	5.1	1.3

***Table A1.**--Concentrations of metals in soil samples analyzed by the total method in Clark County, Wash.--Continued*

Sample number	Aluminum (percent)	Calcium (percent)	Iron (percent)	Potassium (percent)
G190.08 V	8.3	0.9	4.4	0.66
G190.3	8.3	0.8	4.2	0.72
G190.3 V	8.7	0.8	4.7	0.61
G191.0 V	9.5	0.8	4.9	0.55
G191.6 V	9.2	0.7	5.1	0.67
G192.2	9.4	0.5	5.7	0.83
G192.2 V	9.4	0.7	5.8	0.75
G200.3 A	7.3	0.9	4.1	1.8
G200.3 C	7.2	0.9	4.1	1.8
G200.3 V	7.1	0.9	4.1	1.7
G200.8 V	7.2	0.9	4.2	1.8
G201.8 A	7.8	0.8	5	1.9
G201.8 C	7.5	0.8	4.4	1.9
G201.8 V	7.8	0.8	4.9	1.9
G203.0 V	7.9	0.8	6.2	1.6
G205.1 V	8.2	0.9	6.8	1.4
G220.3	8.5	1.6	6.1	0.75
G222.2	8.9	1.6	6.6	0.74
G230.3	8.7	1.7	7.1	0.66
G232.2	9.9	1.3	7.6	0.68
G240.3	9.8	1.9	8.1	0.78
G242.2	10.0	1.4	9	0.69

Table A1.--Concentrations of metals in soil samples analyzed by the total method in Clark County, Wash.--Continued

Sample number		Magnesium (percent)	Sodium (percent)	Phos-phorus (percent)	Titanium (percent)	Manganese (mg/kg)	Silver (mg/kg)	Arsenic (mg/kg)
G10.3		0.9	1.0	0.20	1.30	1,200	<2	<10
G12.5		0.9	0.9	0.18	1.30	1,100	<2	--
G40.3		0.8	1.1	0.21	0.92	1,000	<2	<10
G42.5		0.8	1.1	0.19	0.90	970	<2	--
G50.3		0.8	1.3	0.15	0.87	700	<2	<10
G52.5		0.8	1.2	0.11	0.87	620	<2	--
G70.3		1.1	2.5	0.11	0.56	720	<2	<10
G72.2		1	2.9	0.10	0.51	680	<2	<10
G80.3	B	1.4	1.7	0.16	0.65	870	<2	<10
G80.3	D	1.1	1.8	0.11	0.63	830	<2	<10
G80.3	V	1.2	1.7	0.14	0.63	810	<2	<10
G80.8	V	1.4	1.8	0.17	0.74	990	<2	<10
G81.4	V	1.4	1.6	0.16	0.70	950	<2	<10
G82.2	B	1.3	1.8	0.12	0.67	820	<2	<10
G82.2	D	1.3	1.9	0.11	0.61	740	<2	<10
G82.2	V	1.3	1.8	0.11	0.67	790	<2	<10
G83.0	V	1.3	1.9	0.12	0.63	770	<2	<10
G90.3		1.2	1.3	0.10	0.74	1,000	<2	<10
G92.2		1.1	1.1	0.10	0.75	1,100	<2	<10
G110.3		0.8	1.3	0.20	0.85	1,200	<2	<10
G112.2		0.9	1.1	0.11	0.98	720	<2	<10
G120.3		0.6	1.2	0.14	0.86	1,200	<2	<10
G122.2		0.7	1.0	0.11	0.87	720	<2	<10
G150.3		0.5	0.7	0.10	0.98	530	<2	<10
G152.2		0.6	1	0.15	1.20	700	<2	<10
G160.3		0.6	1.4	0.14	1.20	1,200	<2	<10
G162.2		0.7	1	0.11	1.20	650	<2	<20
G170.3		0.7	1.4	0.17	0.87	1,100	<2	<10
G172.2		0.8	1.3	0.13	0.89	610	<2	<10
G180.3		0.6	1.2	0.11	0.76	1,500	<2	<10
G182.2		0.7	1.1	0.08	0.81	1,200	<2	<10
G190.08	V	0.5	0.8	0.12	0.77	800	<2	<10
G190.3		0.5	0.8	0.12	0.74	570	<2	<10
G190.3	V	0.5	0.7	0.12	0.80	740	<2	<10

Table A1.--*Concentrations of metals in soil samples analyzed by the total method in Clark County, Wash.--Continued*

Sample number		Magnesium (percent)	Sodium (percent)	Phos-phorus (percent)	Titanium (percent)	Manganese (mg/kg)	Silver (mg/kg)	Arsenic (mg/kg)
G191.0	V	0.5	0.7	0.13	0.82	620	<2	<10
G191.6	V	0.5	0.8	0.08	0.99	530	<2	<10
G192.2		0.6	0.7	0.05	0.80	430	<2	<10
G192.2	V	0.6	0.8	0.06	0.96	610	<2	<10
G200.3	A	0.7	1.3	0.16	0.89	990	<2	<10
G200.3	C	0.7	1.4	0.15	0.87	1,000	<2	<10
G200.3	V	0.7	1.3	0.14	0.86	950	<2	<10
G200.8	V	0.7	1.3	0.14	0.87	940	<2	<10
G201.8	A	0.8	1.2	0.12	0.88	670	<2	<10
G201.8	C	0.8	1.2	0.12	0.88	620	<2	<10
G201.8	V	0.8	1.2	0.11	0.89	560	<2	<10
G203.0	V	0.9	1.0	0.11	0.87	670	<2	<10
G205.1	V	0.9	1.0	0.12	0.90	690	<2	<10
G220.3		0.7	1.3	0.18	0.99	1,400	<2	<10
G222.2		0.8	1.3	0.14	1.10	1,300	<2	<10
G230.3		0.9	1.0	0.25	1.00	1,400	<2	<10
G232.2		0.9	0.9	0.22	1.00	1,500	<2	<10
G240.3		1.0	1.3	0.33	1.20	1,800	<2	<10
G242.2		0.8	1.1	0.20	1.30	1,200	<2	<10

Table A1.*--Concentrations of metals in soil samples analyzed by the total method in Clark County, Wash.--Continued*

Sample number	Gold (mg/kg)	Barium (mg/kg)	Beryllium (mg/kg)	Bismuth (mg/kg)	Cadmium (mg/kg)	Cesium (mg/kg)	Cobalt (mg/kg)
G10.3	<8	640	2	<10	<2	60	28
G12.5	<8	670	2	<10	<2	65	27
G40.3	<8	580	1	<10	<2	66	24
G42.5	<8	590	1	<10	<2	59	24
G50.3	<8	750	2	<10	<2	67	15
G52.5	<8	690	2	<10	<2	73	16
G70.3	<8	350	1	<10	<2	38	18
G72.2	<8	340	1	<10	<2	36	15
G80.3 B	<8	700	1	<10	<2	80	21
G80.3 D	<8	640	1	<10	<2	70	17
G80.3 V	<8	660	1	<10	<2	71	19
G80.8 V	<8	700	2	<10	<2	100	23
G81.4 V	<8	680	2	<10	<2	100	24
G82.2 B	<8	710	2	<10	<2	84	19
G82.2 D	<8	720	2	<10	<2	75	18
G82.2 V	<8	680	1	<10	<2	73	20
G83.0 V	<8	730	1	<10	<2	74	18
G90.3	<8	450	1	<10	<2	51	25
G92.2	<8	460	2	<10	<2	65	29
G110.3	<8	770	1	<10	<2	67	19
G112.2	<8	670	2	<10	<2	86	19
G120.3	<8	730	1	<10	<2	79	16
G122.2	<8	660	2	<10	<2	83	16
G150.3	<8	490	1	<10	<2	73	20
G152.2	<8	600	1	<10	<2	62	19
G160.3	<8	700	1	<10	<2	65	19
G162.2	<8	600	1	<10	<2	83	20
G170.3	<8	820	2	<10	<2	69	15
G172.2	<8	750	2	<10	<2	76	15
G180.3	<8	740	1	<10	<2	69	18
G182.2	<8	730	1	<10	<2	81	20
G190.08 V	<8	350	1	<10	<2	72	12
G190.3	<8	360	1	<10	<2	60	11
G190.3 V	<8	340	1	<10	<2	83	12

Table A1.--*Concentrations of metals in soil samples analyzed by the total method in Clark County, Wash.--Continued*

Sample number		Gold (mg/kg)	Barium (mg/kg)	Beryllium (mg/kg)	Bismuth (mg/kg)	Cadmium (mg/kg)	Cesium (mg/kg)	Cobalt (mg/kg)
G191.0	V	<8	300	1	<10	<2	79	10
G191.6	V	<8	320	1	<10	<2	62	12
G192.2		<8	370	1	<10	<2	48	11
G192.2	V	<8	350	1	<10	<2	53	13
G200.3	A	<8	760	2	<10	<2	73	16
G200.3	C	<8	790	2	<10	<2	63	16
G200.3	V	<8	750	1	<10	<2	71	16
G200.8	V	<8	750	2	<10	<2	69	17
G201.8	A	<8	710	2	<10	<2	76	16
G201.8	C	<8	730	2	<10	<2	73	14
G201.8	V	<8	720	2	<10	<2	72	15
G203.0	V	<8	640	2	<10	<2	84	16
G205.1	V	<8	620	2	<10	<2	83	15
G220.3		<8	590	1	<10	<2	71	25
G222.2		<8	560	1	<10	<2	89	28
G230.3		<8	650	1	<10	<2	69	27
G232.2		<8	670	2	<10	<2	85	30
G240.3		<8	770	1	<10	<2	62	34
G242.2		<8	690	1	<10	<2	78	31

Table A1.--Concentrations of metals in soil samples analyzed by the total method in Clark County, Wash.--Continued

Sample number	Chromium (mg/kg)	Copper (mg/kg)	Europium (mg/kg)	Gallium (mg/kg)	Holmium (mg/kg)	Lanthanum (mg/kg)	Lithium (mg/kg)
G10.3	60	36	<2	28	<4	31	23
G12.5	81	39	<2	27	<4	35	24
G40.3	52	47	<2	23	<4	30	25
G42.5	59	49	<2	21	<4	29	25
G50.3	58	20	<2	20	<4	37	25
G52.5	64	27	<2	20	<4	39	24
G70.3	35	48	<2	21	<4	19	22
G72.2	27	51	<2	21	<4	18	23
G80.3 B	80	34	<2	18	<4	45	26
G80.3 D	68	40	<2	19	<4	39	26
G80.3 V	71	39	<2	18	<4	40	25
G80.8 V	94	35	<2	18	<4	57	27
G81.4 V	92	48	<2	20	<4	56	31
G82.2 B	85	34	<2	19	<4	46	27
G82.2 D	76	29	<2	20	<4	42	25
G82.2 V	79	39	<2	18	<4	40	26
G83.0 V	79	26	<2	19	<4	41	24
G90.3	58	73	<2	22	<4	27	26
G92.2	62	76	<2	21	<4	34	30
G110.3	64	28	<2	20	<4	39	28
G112.2	75	32	<2	20	<4	45	28
G120.3	61	23	<2	16	<4	46	23
G122.2	61	27	<2	21	<4	42	25
G150.3	64	36	<2	23	<4	35	27
G152.2	68	35	<2	24	<4	34	24
G160.3	65	18	<2	19	<4	34	22
G162.2	69	25	<2	21	<4	38	24
G170.3	54	17	<2	17	<4	39	23
G172.2	59	18	<2	18	<4	41	24
G180.3	72	26	<2	19	<4	45	25
G182.2	79	30	<2	21	<4	40	27
G190.08 V	45	70	<2	19	<4	38	21
G190.3	54	63	<2	19	<4	32	24
G190.3 V	45	76	<2	20	<4	41	20

Table A1.--Concentrations of metals in soil samples analyzed by the total method in Clark County, Wash.--Continued

Sample number		Chromium (mg/kg)	Copper (mg/kg)	Europium (mg/kg)	Gallium (mg/kg)	Holmium (mg/kg)	Lanthanum (mg/kg)	Lithium (mg/kg)
G191.0	V	44	83	<2	20	<4	41	22
G191.6	V	52	76	<2	21	<4	31	21
G192.2		62	66	<2	21	<4	27	26
G192.2	V	58	68	<2	23	<4	26	22
G200.3	A	56	19	<2	20	<4	39	27
G200.3	C	54	19	<2	20	<4	35	25
G200.3	V	57	22	<2	18	<4	38	24
G200.8	V	56	19	<2	20	<4	38	24
G201.8	A	62	21	<2	20	<4	39	27
G201.8	C	58	20	<2	20	<4	37	25
G201.8	V	61	22	<2	20	<4	39	26
G203.0	V	59	57	<2	20	<4	44	23
G205.1	V	62	38	<2	20	<4	43	23
G220.3		49	34	<2	23	<4	30	19
G222.2		54	35	<2	24	<4	35	20
G230.3		37	38	<2	23	<4	34	16
G232.2		41	34	<2	26	<4	42	17
G240.3		59	39	<2	28	<4	30	18
G242.2		62	41	<2	27	<4	35	19

Table A1.--Concentrations of metals in soil samples analyzed by the total method in Clark County, Wash.--Continued

Sample number		Molybdenum (mg/kg)	Niobium (mg/kg)	Neodymium (mg/kg)	Nickel (mg/kg)	Lead (mg/kg)	Scandium (mg/kg)	Tin (mg/kg)
G10.3		<2	28	30	28	14	29	<5
G12.5		<2	13	42	27	12	34	<5
G40.3		<2	17	27	24	17	18	<5
G42.5		<2	10	25	22	14	18	<5
G50.3		<2	15	31	24	15	14	<5
G52.5		<2	12	35	23	15	18	<5
G70.3		<2	12	20	19	13	14	<5
G72.2		<2	8	20	16	12	13	<5
G80.3	B	<2	17	37	32	23	17	<5
G80.3	D	<2	14	35	27	30	17	<5
G80.3	V	<2	13	37	31	29	16	<5
G80.8	V	<2	18	48	32	19	19	<5
G81.4	V	<2	17	47	39	19	19	<5
G82.2	B	<2	14	41	32	17	17	<5
G82.2	D	<2	18	36	29	15	17	<5
G82.2	V	<2	17	35	31	18	18	<5
G83.0	V	<2	13	37	28	17	16	<5
G90.3		<2	14	27	23	18	24	<5
G92.2		<2	14	34	27	15	25	<5
G110.3		<2	16	32	27	17	14	<5
G112.2		<2	18	40	29	15	20	<5
G120.3		<2	17	37	21	17	13	<5
G122.2		<2	16	37	26	17	18	<5
G150.3		<2	18	34	27	20	22	<5
G152.2		<2	16	35	26	18	23	<5
G160.3		<2	17	28	24	18	14	<5
G162.2		<2	19	32	29	13	22	<5
G170.3		<2	16	31	21	20	12	<5
G172.2		<2	17	36	23	15	16	<5
G180.3		<2	15	34	25	15	13	<5
G182.2		<2	17	35	28	16	16	<5
G190.08	V	<2	14	42	19	17	24	<5
G190.3		<2	12	36	21	17	22	<5
G190.3	V	<2	12	49	19	15	26	<5

Table A1.--Concentrations of metals in soil samples analyzed by the total method in Clark County, Wash.--Continued

Sample number		Molyb-denum (mg/kg)	Niobium (mg/kg)	Neodymium (mg/kg)	Nickel (mg/kg)	Lead (mg/kg)	Scandium (mg/kg)	Tin (mg/kg)
G191.0	V	<2	14	48	19	14	31	<5
G191.6	V	<2	15	35	18	15	29	<5
G192.2		<2	14	26	24	14	24	<5
G192.2	V	<2	16	25	21	15	25	<5
G200.3	A	<2	17	30	21	18	14	<5
G200.3	C	<2	16	29	20	17	13	<5
G200.3	V	<2	16	31	21	18	14	<5
G200.8	V	<2	17	30	20	17	13	<5
G201.8	A	<2	16	32	22	17	17	<5
G201.8	C	<2	15	32	22	15	15	<5
G201.8	V	<2	17	32	23	18	17	<5
G203.0	V	<2	17	39	26	17	21	<5
G205.1	V	<2	16	40	29	18	24	<5
G220.3		<2	13	29	24	25	23	<5
G222.2		<2	14	38	24	18	26	<5
G230.3		<2	15	34	18	27	26	<5
G232.2		<2	16	44	18	15	33	<5
G240.3		<2	14	30	27	21	29	<5
G242.2		<2	21	41	29	13	38	<5

Table A1.--Concentrations of metals in soil samples analyzed by the total method in Clark County, Wash.--Continued

Sample number		Strontium (mg/kg)	Tantalum (mg/kg)	Thorium (mg/kg)	Uranium (mg/kg)	Vanadium (mg/kg)	Yttrium (mg/kg)	Ytterbium (mg/kg)
G10.3		170	<40	18	<100	270	25	3
G12.5		170	<40	11	<100	270	36	4
G40.3		170	<40	16	<100	180	17	2
G42.5		180	<40	8	<100	180	17	2
G50.3		210	<40	21	<100	150	13	2
G52.5		190	<40	12	<100	170	18	2
G70.3		380	<40	11	<100	110	16	2
G72.2		420	<40	4	<100	100	17	2
G80.3	B	330	<40	12	<100	150	26	3
G80.3	D	310	<40	9	<100	130	24	3
G80.3	V	310	<40	9	<100	140	24	3
G80.8	V	350	<40	14	<100	170	30	3
G81.4	V	320	<40	14	<100	160	33	3
G82.2	B	320	<40	11	<100	150	26	3
G82.2	D	340	<40	23	<100	130	24	3
G82.2	V	320	<40	9	<100	150	26	3
G83.0	V	360	<40	10	<100	140	23	3
G90.3		200	<40	8	<100	180	23	2
G92.2		190	<40	11	<100	190	27	3
G110.3		220	<40	12	<100	160	15	2
G112.2		190	<40	13	<100	200	21	3
G120.3		200	<40	12	<100	140	18	2
G122.2		160	<40	14	<100	170	19	2
G150.3		130	<40	13	<100	190	21	3
G152.2		180	<40	11	<100	210	23	2
G160.3		220	<40	10	<100	170	13	2
G162.2		180	<40	10	<100	200	20	3
G170.3		220	<40	11	<100	150	15	2
G172.2		200	<40	12	<100	160	18	2
G180.3		200	<40	9	<100	140	16	2
G182.2		190	<40	12	<100	150	16	2
G190.08	V	140	<40	7	<100	140	37	4
G190.3		130	<40	6	<100	130	29	3
G190.3	V	140	<40	6	<100	140	44	4
G191.0	V	130	<40	5	<100	140	48	4

Table A1.--Concentrations of metals in soil samples analyzed by the total method in Clark County, Wash.--Continued

Sample number		Strontium (mg/kg)	Tantalum (mg/kg)	Thorium (mg/kg)	Uranium (mg/kg)	Vanadium (mg/kg)	Yttrium (mg/kg)	Ytterbium (mg/kg)
G191.6	V	130	<40	5	<100	160	30	3
G192.2		110	<40	7	<100	170	17	2
G192.2	V	130	<40	7	<100	180	19	2
G200.3	A	200	<40	18	<100	150	14	2
G200.3	C	200	<40	17	<100	150	13	2
G200.3	V	200	<40	9	<100	150	14	1
G200.8	V	200	<40	18	<100	150	14	2
G201.8	A	180	<40	9	<100	160	16	2
G201.8	C	190	<40	17	<100	150	15	2
G201.8	V	180	<40	10	<100	160	16	2
G203.0	V	200	<40	11	<100	180	24	3
G205.1	V	190	<40	12	<100	200	31	3
G220.3		220	<40	6	<100	200	27	3
G222.2		220	<40	7	<100	210	34	3
G230.3		210	<40	7	<100	220	31	3
G232.2		200	<40	8	<100	220	44	4
G240.3		230	<40	7	<100	250	28	3
G242.2		220	<40	8	<100	270	40	4

Table A1.--*Concentrations of metals in soil samples analyzed by the total method in Clark County, Wash.--Continued*

Sample number		Zinc (mg/kg)
G10.3		140
G12.5		130
G40.3		130
G42.5		120
G50.3		120
G52.5		94
G70.3		76
G72.2		64
G80.3	B	120
G80.3	D	210
G80.3	V	200
G80.8	V	100
G81.4	V	110
G82.2	B	88
G82.2	D	86
G82.2	V	89
G83.0	V	83
G90.3		120
G92.2		110
G110.3		130
G112.2		110
G120.3		99
G122.2		96
G150.3		98
G152.2		120
G160.3		110
G162.2		100
G170.3		120
G172.2		100
G180.3		110
G182.2		110
G190.08	V	86
G190.3		93
G190.3	V	88
G191.0	V	86

Table A1.--Concentrations of metals in soil samples analyzed by the total method in Clark County, Wash.--Continued

Sample number		Zinc (mg/kg)
G191.6	V	73
G192.2		67
G192.2	V	74
G200.3	A	120
G200.3	C	120
G200.3	V	110
G200.8	V	110
G201.8	A	100
G201.8	C	100
G201.8	V	100
G203.0	V	100
G205.1	V	100
G220.3		120
G222.2		110
G230.3		130
G232.2		110
G240.3		160
G242.2		130

__Table A2.__--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.

[Concentrations are in milligrams per kilogram of dry soil except total and total-recoverable values for iron and aluminum, which are given in percent; values in parentheses are given in milligrams per liter of leachate; --, no data; <, indicates a value less than the laboratory's minimum reporting value]

Sample number	Aluminum					
	Total	Total recoverable	ASTM		TCLP	
G10.3	9.5	4.07	--		--	
G12.2	10	4.69	--		--	
G20.3	--	2.25	--		--	
G22.2	--	1.78	--		--	
G30.3	--	2.6	--		--	
G32.2	--	1.87	--		--	
G40.3	9.2	3.59	--		--	
G42.2	9.2	3.98	--		--	
G50.3	7.5	1.64	--		--	
G52.2	7.7	3.41	<1	(<0.05)	6.4	(0.32)
G60.3	--	1.13	--		--	
G62.2	--	4.25	--		--	
G70.3	8.4	1.61	1.6	(0.08)	6.5	(0.32)
G72.2	8.9	1.14	--		--	
G80.3 A	--	1.65	--		--	
G80.3 B	7.4	1.49	--		--	
G80.3 C	--	1.78	--		--	
G80.3 D	7.4	1.97	--		--	
G80.3 V	7.2	2.1	2.8	(0.14)	3.7	(0.19)
G80.8 V	7.5	1.57	1.5	(0.08)	3.9	(0.2)
G81.4 V	7.8	1.48	1.5	(0.08)	2	(0.1)
G82.2 A	--	2.11	--		--	
G82.2 B	7.6	2.24	--		--	
G82.2 C	--	1.96	--		--	
G82.2 D	7.6	2.07	--		--	
G82.2 V	7.6	2.49	7.3	(0.40)	3.1	(0.15)
G83.0 V	7.4	2.25	6.9	(0.34)	2.6	(0.13)
G90.3	8.6	3.33	1.3	(0.07)	5	(0.25)
G92.2	8.8	1.77	0.08	(0.04)	12.1	(0.60)
G100.3	--	2.09	--		--	
G102.2	--	2.87	--		--	
G110.3	7.8	3.14	4.3	(0.21)	11.3	(0.56)
G112.2	8.6	3.24	7.1	(0.36)	8.5	(0.42)

Table A2.*--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number		Aluminum					
		Total	Total recoverable	ASTM		TCLP	
G120.3		6.8	2.99	8	(0.4)	8.7	(0.43)
G122.2		8.3	3.46	--		--	
G130.3		--	1.6	--		--	
G132.2		--	3.28	--		--	
G140.3		--	2.56	2.2	(0.11)	13.4	(0.67)
G142.2		--	2.96	--		--	
G150.3		9.6	5.35	3	(0.15)	7	(0.35)
G152.2		9.2	3.3	--		--	
G160.3		7.4	2.6	--		--	
G162.2		8.4	2.74	--		--	
G170.3		7	2.88	4	(0.2)	12.9	(0.64)
G172.2		7.6	3.18	7.1	(0.3)	6.2	(0.31)
G180.3		7.3	3.85	1.7	(0.9)	13.8	(0.69)
G182.2		8.2	4.51	1	(0.5)	14.5	(0.72)
G190.08	V	8.3	3.58	--		--	
G190.3		8.3	4.91	10.4	(0.52)	7.1	(0.36)
G190.3	V	8.7	5.02	--		--	
G191.0	V	9.5	5.1	--		--	
G191.6	V	9.2	4.23	--		--	
G192.2		9.4	5.92	--		--	
G192.2	V	9.4	5.3	--		--	
G200.3	A	7.3	2.76	--		--	
G200.3	B	--	2.96	--		--	
G200.3	C	7.2	2.62	--		--	
G200.3	D	--	3.01	--		--	
G200.3	V	7.1	2.88	3.3	(0.17)	10.1	(0.51)
G200.8	V	7.2	3.04	2.8	(0.14)	8.4	(0.42)
G201.8	A	7.8	3.3	--		--	
G201.8	B	--	2.76	--		--	
G201.8	C	7.5	3.09	--		--	
G201.8	D	--	3.58	--		--	
G201.8	V	7.8	1.9	3.2	(0.16)	7.04	(0.35)
G203.0	V	7.9	3.95	1	(0.05)	9.7	(0.49)
G205.1	V	8.2	4.43	2.2	(0.11)	8.8	(0.44)
G210.3		--	5.29	--		--	
G212.2		--	6.98	--		--	
G220.3		8.5	4.83	2.8	(0.14)	10	(0.5)
G222.2		8.9	4.72	2.2	(0.11)	15	(0.75)

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number	Aluminum					
	Total	Total recoverable	ASTM		TCLP	
G230.3	8.7	4.7	3.4	(0.17)	8.48	(0.42)
G232.2	9.9	5.31	1.9	(0.1)	12.3	(0.61)
G240.3	9.8	3.88	6.5	(0.32)	13	(0.65)
G242.2	10	4.89	--		--	
G250.3	--	4.77	--		--	
G252.2	--	4.37	--		--	
G260.3	--	4.61	--		--	
G262.2	--	5.09	--		--	

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number		Iron					
		Total	Total recoverable	ASTM		TCLP	
G10.3		8.4	5	--		--	
G12.2		8.8	5.57	--		--	
G20.3		--	3.66	--		--	
G22.2		--	3.01	--		--	
G30.3		--	3.57	--		--	
G32.2		--	2.71	--		--	
G40.3		5.9	3.74	--		--	
G42.2		5.8	3.4	--		--	
G50.3		4.4	3	--		--	
G52.2		5.4	4.01	<0.4	(<0.02)	0.9	(0.05)
G52.5		5.4	--	--		--	
G60.3		--	1.39	--		--	
G62.2		--	6.94	--		--	
G70.3		4	1.77	1.6	(0.08)	1.8	(0.09)
G72.2		3.7	1.5	--		--	
G80.3	A	--	2.49	--		--	
G80.3	B	4.9	2.26	--		--	
G80.3	C	--	2.7	--		--	
G80.3	D	4.4	2.84	--		--	
G80.3	V	4.6	2.61	3.2	(0.16)	1.1	(0.05)
G80.8	V	5.2	2.16	2.1	(0.11)	1.3	(0.06)
G81.4	V	5.5	2.12	2.2	(0.11)	0.9	(0.04)
G82.2	A	--	2.75	--		--	
G82.2	B	4.7	2.99	--		--	
G82.2	C	--	2.68	--		--	
G82.2	D	4.3	2.76	--		--	
G82.2	V	4.6	2.88	9.9	(0.5)	1.5	(0.08)
G83.0	V	4.3	2.72	8.7	(0.44)	1	(0.05)
G90.3		5.7	3.66	1.4	(0.07)	0.7	(0.04)
G92.2		6.1	2.2	1.3	(0.06)	1.5	(0.77)
G100.3		--	2.6	--		--	
G102.2		--	3.26	--		--	
G110.3		4.9	3.06	2.9	(0.15)	1.2	(0.06)
G112.2		6	3.35	4.3	(0.22)	0.3	(0.01)
G120.3		4.1	3.03	6.5	(0.32)	1	(0.05)
G122.2		5.3	3.98	--		--	

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number		Iron					
		Total	Total recoverable	ASTM		TCLP	
G130.3		--	1.99	--		--	
G132.2		--	5.5	--		--	
G140.3		--	3.43	2.8	(0.14)	1	(0.05)
G142.2		--	4.52	--		--	
G150.3		5.7	4.88	1	(0.05)	0.4	(0.02)
G152.2		5.9	4.19	--		--	
G160.3		5.1	5.69	--		--	
G162.2		6.7	5.3	--		--	
G170.3		4	3.13	2.6	(0.13)	1.1	(0.05)
G172.2		4.7	3.52	4.7	(0.24)	0.3	(0.01)
G180.3		4.5	3.27	9.2	(0.46)	0.8	(0.04)
G182.2		5.1	3.75	6.6	(0.33)	0.4	(0.02)
G190.08	V	4.4	5.65	--		--	
G190.3		4.2	4.04	9.7	(0.49)	0.6	(0.03)
G190.3	V	4.7	4.37	--		--	
G191.0	V	4.9	5.9	--		--	
G191.6	V	5.1	7.76	--		--	
G192.2		5.7	5.44	--		--	
G192.2	V	5.8	5.74	--		--	
G200.3	A	4.1	3.31	--		--	
G200.3	B	--	3.65	--		--	
G200.3	C	4.1	3.13	--		--	
G200.3	D	--	3.86	--		--	
G200.3	V	4.1	3.24	2.9	(0.15)	0.5	(0.03)
G200.8	V	4.2	3.3	3	(0.15)	0.8	(0.04)
G201.8	A	5	4.16	--		--	
G201.8	B	--	3.41	--		--	
G201.8	C	4.4	3.81	--		--	
G201.8	D	--	4.16	--		--	
G201.8	V	4.9	2.12	3.1	(0.15)	0.4	(0.02)
G203.0	V	6.2	5.13	1	(0.05)	2.9	(0.14)
G205.1	V	6.8	5.15	0.9	(0.05)	0.3	(0.01)
G210.3		--	3.37	--		--	
G212.2		--	4.35	--		--	
G220.3		6.1	4.9	1.3	(0.06)	0.7	(0.03)
G222.2		6.6	4.51	1.3	(0.06)	1	(0.05)

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number	Iron					
	Total	Total recoverable	ASTM		TCLP	
G230.3	7.1	4.92	2.1	(0.1)	1.2	(0.06)
G232.2	7.6	5.12	1.1	(0.06)	0.8	(0.04)
G240.3	8.1	5.29	3.1	(0.16)	1.3	(0.06)
G242.2	9	5.68	--		--	
G250.3	--	5.62	--		--	
G252.2	--	5.99	--		--	
G260.3	--	5.69	--		--	
G262.2	--	6.28	--		--	

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number		Manganese					
		Total	Total recoverable	ASTM		TCLP	
G10.3		1,200	984	--		--	
G12.2		1,100	825	--		--	
G20.3		--	857	--		--	
G22.2		--	478	--		--	
G30.3		--	837	--		--	
G32.2		--	494	--		--	
G40.3		1,000	1,010	--		--	
G42.2		970	686	--		--	
G50.3		700	1,210	--		--	
G52.2		620	644	--		3.6	(0.18)
G60.3		--	230	--		--	
G62.2		--	70	--		--	
G70.3		720	256	0.1	(0.005)	0.5	(0.03)
G72.2		680	207	--		--	
G80.3	A	--	412	--		--	
G80.3	B	870	344	--		--	
G80.3	C	--	485	--		--	
G80.3	D	830	521	--		--	
G80.3	V	810	450	0.1	(0.005)	0.3	(0.02)
G80.8	V	990	306	0.1	(0.005)	0.2	(0.01)
G81.4	V	950	307	0.06	(0.003)	0.2	(0.01)
G82.2	A	--	452	--		--	
G82.2	B	820	463	--		--	
G82.2	C	--	414	--		--	
G82.2	D	740	483	--		--	
G82.2	V	790	425	0.2	(0.01)	0.3	(0.01)
G83.0	V	770	408	0.2	(0.01)	0.3	(0.01)
G90.3		1,000	726	0.1	(0.005)	0.9	(0.04)
G92.2		1,100	293	0.08	(0.004)	0.6	(0.03)
G100.3		--	1,180	--		--	
G102.2		--	673	--		--	
G110.3		1,200	1,100	0.3	(0.01)	0.9	(0.04)
G112.2		720	562	0.1	(0.005)	0.6	(0.03)
G120.3		1,200	1,688	0.6	(0.03)	0.9	(0.04)
G122.2		720	1,210	--		--	

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number		Manganese Total	Total recoverable	ASTM		TCLP	
G130.3		--	365	--		--	
G132.2		--	1,250	--		--	
G140.3		--	536	0.1	(0.005)	0.9	(0.04)
G142.2		--	912	--		--	
G150.3		530	434	0.1	(0.006)	1.1	(0.05)
G152.2		700	540	--		--	
G160.3		1,200	1,030	--		--	
G162.2		650	1,190	--		--	
G170.3		1,100	2,140	0.4	(0.02)	0.8	(0.04)
G172.2		610	911	0.2	(0.01)	0.3	(0.02)
G180.3		1,500	1,770	0.1	(0.005)	0.9	(0.04)
G182.2		1,200	1,370	0.2	(0.002)	0.6	(0.03)
G190.08	V	800	2,610	--		--	
G190.3		570	1,100	0.3	(0.02)	0.9	(0.04)
G190.3	V	740	1,870	--		--	
G191.0	V	620	1,850	--		--	
G191.6	V	530	4,060	--		--	
G192.2		430	616	--		--	
G192.2	V	610	1,620	--		--	
G200.3	A	990	1,610	--		--	
G200.3	B	--	1,430	--		--	
G200.3	C	1,000	1,670	--		--	
G200.3	D	--	1,730	--		--	
G200.3	V	950	1,430	0.1	(0.007)	0.5	(0.03)
G200.8	V	940	1,330	0.2	(0.008)	0.4	(0.02)
G201.8	A	670	1,240	--		--	
G201.8	B	--	1,300	--		--	
G201.8	C	620	1,040	--		--	
G201.8	D	--	743	--		--	
G201.8	V	560	387	0.04	(0.002)	0.1	(0.005)
G203.0	V	670	804	0.03	(0.001)	0.2	(0.01)
G205.1	V	690	784	0.02	(<0.001)	0.3	(0.02)
G210.3		--	1,640	--		--	
G212.2		--	639	--		--	
G220.3		1,400	1,160	0.1	(0.006)	0.9	(0.04)
G222.2		1,300	870	0.1	(0.005)	1	(0.05)

***Table A2.**--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number	Manganese					
	Total	Total recoverable	ASTM		TCLP	
G230.3	1,400	963	<0.1	(<0.01)	0.4	(0.02)
G232.2	1,500	942	<0.1	(<0.01)	1.3	(0.07)
G240.3	1,800	986	0.4	(0.02)	1	(0.05)
G242.2	1,200	1,040	--		--	
G250.3	--	989	--		--	
G252.2	--	816	--		--	
G260.3	--	928	--		--	
G262.2	--	974	--		--	

Table A2.--*Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number		Silver					
		Total	Total recoverable	ASTM		TCLP	
G10.3		<2	<0.3	--		--	
G12.2		<2	<0.2	--		--	
G20.3		--	<0.3	--		--	
G22.2		--	<0.2	--		--	
G30.3		--	<0.3	--		--	
G32.2		--	<0.2	--		--	
G40.3		<2	<0.3	--		--	
G42.2		<2	<0.2	--		--	
G50.3		<2	<0.3	--		--	
G52.2		<2	<0.2	0.1	(<0.003)	0.1	(<0.003)
G60.3		--	<0.3	--		--	
G62.2		--	<0.3	--		--	
G70.3		<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G72.2		<2	<0.3	--		--	
G80.3	A	--	<0.3	--		--	
G80.3	B	<2	<0.3	--		--	
G80.3	C	--	<0.3	--		--	
G80.3	D	<2	<0.3	--		--	
G80.3	V	<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G80.8	V	<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G81.4	V	<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G82.2	A	--	<0.3	--		--	
G82.2	B	<2	<0.3	--		--	
G82.2	C	--	<0.3	--		--	
G82.2	D	<2	<0.3	--		--	
G82.2	V	<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G83.0	V	<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G90.3		<2	<0.42	<0.1	(<0.003)	<0.1	(<0.003)
G92.2		<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G100.3		--	<0.3	--		--	
G102.2		--	<0.3	--		--	
G110.3		<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G112.2		<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G120.3		<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G122.2		<2	<0.3	--		--	

Table A2.*--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number		Silver					
		Total	Total recoverable	ASTM		TCLP	
G130.3		--	<0.3	--		--	
G132.2		--	<0.37	--		--	
G140.3		--	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G142.2		--	<0.4	--		--	
G150.3		<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G152.2		<2	<0.31	--		--	
G160.3		<2	<0.38	--		--	
G162.2		<2	<0.37	--		--	
G170.3		<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G172.2		<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G180.3		<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G182.2		<2	<0.32	<0.1	(<0.003)	<0.1	(<0.003)
G190.08	V	<2	<0.37	--		--	
G190.3		<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G190.3	V	<2	<0.46	--		--	
G191.0	V	<2	<0.71	--		--	
G191.6	V	<2	<0.75	--		--	
G192.2		<2	<0.63	--		--	
G192.2	V	<2	<0.73	--		--	
G200.3	A	<2	<0.3	--		--	
G200.3	B	--	<0.3	--		--	
G200.3	C	<2	<0.3	--		--	
G200.3	D	--	<0.3	--		--	
G200.3	V	<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G200.8	V	<2	<0.37	<0.1	(<0.003)	<0.1	(<0.003)
G201.8	A	<2	<0.3	--		--	
G201.8	B	--	<0.3	--		--	
G201.8	C	<2	<0.3	--		--	
G201.8	D	--	<0.33	--		--	
G201.8	V	<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G203.0	V	<2	<0.6	<0.1	(<0.003)	<0.1	(<0.003)
G205.1	V	<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G210.3		--	<0.3	--		--	
G212.2		--	<0.49	--		--	
G220.3		<2	<0.35	<0.1	(<0.003)	<0.1	(<0.003)
G222.2		<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)

Table A2.*--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number	Silver					
	Total	Total recoverable	ASTM		TCLP	
G230.3	<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G232.2	<2	<0.41	<0.1	(<0.003)	<0.1	(<0.003)
G240.3	<2	<0.3	<0.1	(<0.003)	<0.1	(<0.003)
G242.2	<2	<0.3	--		--	
G250.3	--	<0.3	--		--	
G252.2	--	<0.3	--		--	
G260.3	--	<0.3	--		--	
G262.2	--	<0.3	--		--	

Table A2.--*Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number		Arsenic					
		Total	Total recoverable	ASTM		TCLP	
G10.3		<10	2.6	--		--	
G12.2		--	2.9	--		--	
G20.3		--	1.9	--		--	
G22.2		--	1.5	--		--	
G30.3		--	4.8	--		--	
G32.2		--	2.8	--		--	
G40.3		<10	8	--		--	
G42.2		--	5.54	--		--	
G50.3		<10	3.6	--		--	
G52.2		--	6.89	<0.6	(<0.03)	<0.6	(<0.03)
G60.3		--	1.4	--		--	
G62.2		--	<0.5	--		--	
G70.3		<10	2.12	<0.6	(<0.03)	<0.6	(<0.03)
G72.2		<10	1.4	--		--	
G80.3	A	--	4.2	--		--	
G80.3	B	<10	3.6	--		--	
G80.3	C	--	7.9	--		--	
G80.3	D	<10	8.8	--		--	
G80.3	V	<10	5.65	<0.6	(<0.03)	<0.6	(<0.03)
G80.8	V	<10	2.82	<0.6	(<0.03)	<0.6	(<0.03)
G81.4	V	<10	2.7	<0.6	(<0.03)	<0.6	(<0.03)
G82.2	A	--	4.6	--		--	
G82.2	B	<10	4.5	--		--	
G82.2	C	--	5	--		--	
G82.2	D	<10	6.1	--		--	
G82.2	V	<10	4.56	<0.6	(<0.03)	<0.6	(<0.03)
G83	V	<10	3.25	<0.6	(<0.03)	<0.6	(<0.03)
G90.3		<10	6.74	<0.6	(<0.03)	<0.6	(<0.03)
G92.2		<10	3.65	<0.6	(<0.03)	<0.6	(<0.03)
G100.3		--	2.3	--		--	
G102.2		--	3.3	--		--	
G110.3		<10	2.85	<0.6	(<0.03)	<0.6	(<0.03)
G112.2		<10	3.31	<0.6	(<0.03)	<0.6	(<0.03)
G120.3		<10	3.42	<0.6	(<0.03)	<0.6	(<0.03)
G122.2		<10	4.6	--		--	

Table A2.--*Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number		Arsenic					
		Total	Total recoverable	ASTM		TCLP	
G130.3		--	2.3	--		--	
G132.2		--	7.7	--		--	
G140.3		--	3.89	<0.6	(<0.03)	<0.6	(<0.03)
G142.2		--	7.2	--		--	
G150.3		<10	2.64	<0.6	(<0.03)	<0.6	(<0.03)
G152.2		<10	2.8	--		--	
G160.3		<10	9.8	--		--	
G162.2		<20	9.7	--		--	
G170.3		<10	3.16	<0.6	(<0.03)	<0.6	(<0.03)
G172.2		<10	4.18	<0.6	(<0.03)	<0.6	(<0.03)
G180.3		<10	2.7	<0.6	(<0.03)	<0.6	(<0.03)
G182.2		<10	3.14	<0.6	(<0.03)	<0.6	(<0.03)
G190.08	V	<10	6	--		--	
G190.3		<10	5.56	<0.6	(<0.03)	<0.6	(<0.03)
G190.3	V	<10	4.8	--		--	
G191	V	<10	4.09	--		--	
G191.6	V	<10	6.21	--		--	
G192.2		<10	7.87	--		--	
G192.2	V	<10	6.44	--		--	
G200.3	A	<10	4.33	--		--	
G200.3	B	--	4.37	--		--	
G200.3	C	<10	4.5	--		--	
G200.3	D	--	5.57	--		--	
G200.3	V	<10	3.8	<0.6	(<0.03)	<0.6	(<0.03)
G200.8	V	<10	4.1	<0.6	(<0.03)	<0.6	(<0.03)
G201.8	A	<10	6.29	--		--	
G201.8	B	--	3.7	--		--	
G201.8	C	<10	5.51	--		--	
G201.8	D	--	5.92	--		--	
G201.8	V	<10	3.7	<0.6	(<0.03)	<0.6	(<0.03)
G203	V	<10	8.34	<0.6	(<0.03)	<0.6	(<0.03)
G205.1	V	<10	7.3	<0.6	(<0.03)	<0.6	(<0.03)
G210.3		--	3.75	--		--	
G212.2		--	4.48	--		--	
G220.3		<10	1.6	<0.6	(<0.03)	<0.6	(<0.03)
G222.2		<10	1.3	<0.6	(<0.03)	<0.6	(<0.03)

Table A2.*--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number	Arsenic					
	Total	Total recoverable	ASTM		TCLP	
G230.3	<10	2	<0.6	(<0.03)	<0.6	(<0.03)
G232.2	<10	2.3	<0.6	(<0.03)	<0.6	(<0.03)
G240.3	<10	2.2	<0.6	(<0.03)	<0.6	(<0.03)
G242.2	<10	3.01	--		--	
G250.3	--	2.7	--		--	
G252.2	--	2.6	--		--	
G260.3	--	1.9	--		--	
G262.2	--	2.1	--		--	

Table A2.--*Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number		Barium: Total	Barium: Total recoverable	Barium: ASTM		Barium: TCLP	
G10.3		640	--	--		--	
G12.2		670	--	--		--	
G20.3		--	--	--		--	
G22.2		--	--	--		--	
G30.3		--	--	--		--	
G32.2		--	--	--		--	
G40.3		580	--	--		--	
G42.2		--	--	--		--	
G42.5		590	--	--		--	
G50.3		750	--	--		--	
G52.2		690	--	0.7	(0.03)	--	
G60.3		--	--	--		--	
G62.2		--	--	--		--	
G70.3		350	--	2.4	(0.12)	7.5	(0.4)
G72.2		340	--	--		--	
G80.3	A	--	--	--		--	
G80.3	B	700	--	--		--	
G80.3	C	--	--	--		--	
G80.3	D	640	--	--		--	
G80.3	V	660	--	4.1	(0.2)	12.5	(0.62)
G80.8	V	700	--	1.4	(0.07)	9.3	(0.47)
G81.4	V	680	--	0.3	(0.02)	5.8	(0.29)
G82.2	A	--	--	--		--	
G82.2	B	710	--	--		--	
G82.2	C	--	--	--		--	
G82.2	D	720	--	--		--	
G82.2	V	680	--	5.2	(0.26)	11.4	(0.57)
G83.0	V	730	--	5.2	(0.26)	8.9	(0.45)
G90.3		450	--	0.4	(0.02)	11.9	(0.60)
G92.2		460	--	0.2	(0.01)	7	(0.35)
G100.3		--	--	--		--	
G102.2		--	--	--		--	
G110.3		770	--	2.7	(0.14)	21.2	(1.06)
G112.2		670	--	4.6	(0.23)	19.6	(0.98)
G120.3		730	--	4.4	(0.22)	19.8	(1)
G122.2		660	--	--		--	

Table A2.*--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number		Barium					
		Total	Total recoverable	ASTM		TCLP	
G130.3		--	--	--		--	
G132.2		--	--	--		--	
G140.3		--	--	2.2	(0.11)	13	(0.65)
G142.2		--	--	--		--	
G150.3		490	--	4.1	(0.20)	18.3	(0.91)
G152.2		600	--	--		--	
G160.3		700	--	--		--	
G162.2		600	--	--		--	
G170.3		820	--	3.6	(0.18)	21.8	(1.09)
G172.2		750	--	3.1	(0.15)	23.8	(1.19)
G180.3		740	--	1	(0.05)	27.8	(1.39)
G182.2		730	--	0.3	(0.01)	32.2	(1.61)
G190.08	V	350	--	--		--	
G190.3		360	--	4	(0.20)	19.8	(0.99)
G190.3	V	340	--	--		--	
G191.0	V	300	--	--		--	
G191.6	V	320	--	--		--	
G192.2		370	--	--		--	
G192.2	V	350	--	--		--	
G200.3	A	760	--	--		--	
G200.3	B	--	--	--		--	
G200.3	C	790	--	--		--	
G200.3	D	--	--	--		--	
G200.3	V	750	--	0.2	(0.01)	18.4	(0.92)
G200.8	V	750	--	0.1	(0.01)	18.5	(0.92)
G201.8	A	710	--	--		--	
G201.8	B	--	--	--		--	
G201.8	C	730	--	--		--	
G201.8	D	--	--	--		--	
G201.8	V	720	--	0.1	(0.003)	19.9	(0.99)
G203.0	V	640	--	0.2	(0.01)	24.4	(1.22)
G205.1	V	620	--	1.7	(0.09)	24.6	(1.23)
G210.3		--	--	--		--	
G212.2		--	--	--		--	
G220.3		590	--	0.6	(0.03)	17.1	(0.86)
G222.2		560	--	0.8	(0.04)	24	(1.2)

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number	Barium					
	Total	Total recoverable	ASTM		TCLP	
G230.3	650	--	1	(0.05)	24.8	(1.24)
G232.2	670	--	0.2	(0.01)	3.3	(0.16)
G240.3	770	--	4.6	(0.23)	27	(1.35)
G242.2	690	--	--		--	
G250.3	--	--	--		--	
G252.2	--	--	--		--	
G260.3	--	--	--		--	
G262.2	--	--	--		--	

***Table A2.**--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number		Beryllium					
		Total	Total recoverable	ASTM		TCLP	
G10.3		2	1.64	--		--	
G12.2		2	1.03	--		--	
G20.3		--	1.09	--		--	
G22.2		--	0.41	--		--	
G30.3		--	1.48	--		--	
G32.2		--	0.79	--		--	
G40.3		1	1.3	--		--	
G42.2		1	0.74	--		--	
G50.3		2	1.15	--		--	
G52.2		2	0.85	<0.4	(<0.02)	<0.4	(<0.02)
G60.3		--	0.42	--		--	
G62.2		--	0.19	--		--	
G70.3		1	0.68	<0.02	(<0.001)	<0.2	(<0.001)
G72.2		1	0.49	--		--	
G80.3	A	--	0.87	--		--	
G80.3	B	1	0.77	--		--	
G80.3	C	--	0.93	--		--	
G80.3	D	1	0.98	--		--	
G80.3	V	1	1.05	<0.02	(<0.001)	<0.02	(<0.001)
G80.8	V	2	0.87	<0.02	(<0.001)	<0.02	(<0.001)
G81.4	V	2	0.78	<0.02	(<0.001)	<0.02	(<0.001)
G82.2	A	--	1.17	--		--	
G82.2	B	2	1.19	--		--	
G82.2	C	--	1.06	--		--	
G82.2	D	2	1.16	--		--	
G82.2	V	1	1.32	<0.02	(<0.001)	<0.02	(<0.001)
G83.0	V	1	1.25	<0.02	(<0.001)	<0.02	(<0.001)
G90.3		1	1.36	<0.02	(<0.001)	<0.02	(<0.001)
G92.2		2	0.82	<0.02	(<0.001)	<0.02	(<0.001)
G100.3		--	1.01	--		--	
G102.2		--	1.21	--		--	
G110.3		1	1.32	<0.02	(<0.001)	<0.02	(<0.001)
G112.2		2	1.36	<0.02	(<0.001)	<0.02	(<0.001)
G120.3		1	1.46	<0.02	(<0.001)	<0.02	(<0.001)
G122.2		2	1.57	--		--	

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number		Beryllium					
		Total	Total recoverable	ASTM		TCLP	
G130.3		--	0.95	--		--	
G132.2		--	1.95	--		--	
G140.3		--	1.53	<0.02	(<0.001)	<0.02	(<0.001)
G142.2		--	1.81	--		--	
G150.3		1	1.9	<0.02	(<0.001)	<0.02	(<0.001)
G152.2		1	1.6	--		--	
G160.3		1	1.93	--		--	
G162.2		1	1.95	--		--	
G170.3		2	1.48	<0.02	(<0.001)	<0.02	(<0.001)
G172.2		2	1.47	<0.02	(<0.001)	<0.02	(<0.001)
G180.3		1	1.44	<0.02	(<0.001)	<0.02	(<0.001)
G182.2		1	1.52	<0.02	(<0.001)	<0.02	(<0.001)
G190.08	V	1	2.34	--		--	
G190.3		1	1.93	<0.02	(<0.001)	<0.02	(<0.001)
G190.3	V	1	2.12	--		--	
G191.0	V	1	2.45	--		--	
G191.6	V	1	2.51	--		--	
G192.2		1	1.76	--		--	
G192.2	V	1	1.98	--		--	
G200.3	A	2	1.42	--		--	
G200.3	B	--	1.46	--		--	
G200.3	C	2	1.29	--		--	
G200.3	D	--	1.6	--		--	
G200.3	V	1	1.49	<0.02	(<0.001)	<0.02	(<0.001)
G200.8	V	2	1.52	<0.02	(<0.001)	<0.02	(<0.001)
G201.8	A	2	1.56	--		--	
G201.8	B	--	1.33	--		--	
G201.8	C	2	1.46	--		--	
G201.8	D	--	1.61	--		--	
G201.8	V	2	0.9	<0.02	(<0.001)	<0.02	(<0.001)
G203.0	V	2	1.7	<0.02	(<0.001)	<0.02	(<0.001)
G205.1	V	2	1.95	<0.02	(<0.001)	<0.02	(<0.001)
G210.3		--	2.07	--		--	
G212.2		--	2.09	--		--	
G220.3		1	1.8	<0.02	(<0.001)	<0.02	(<0.001)
G222.2		1	1.72	<0.02	(<0.001)	<0.02	(<0.001)

Table A2.*--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number	Beryllium					
	Total	Total recoverable	ASTM		TCLP	
G230.3	1	1.78	<0.02	(<0.001)	<0.02	(<0.001)
G232.2	2	1.96	<0.02	(<0.001)	<0.02	(<0.001)
G240.3	1	1.8	<0.02	(<0.001)	<0.02	(<0.001)
G242.2	1	1.85	--		--	
G250.3	--	1.88	--		--	
G252.2	--	2.03	--		--	
G260.3	--	1.85	--		--	
G262.2	--	2.13	--		--	

Table A2.*--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number		Cadmium			
		Total	Total recoverable	ASTM	TCLP
G10.3		<2	0.97	--	--
G12.2		<2	0.2	--	--
G20.3		--	0.77	--	--
G22.2		--	0.2	--	--
G30.3		--	1.3	--	--
G32.2		--	0.2	--	--
G40.3		<2	0.91	--	--
G42.2		<2	0.2	--	--
G50.3		<2	0.79	--	--
G52.2		<2	0.2	<0.04 (<0.002)	<0.04 (<0.002)
G60.3		--	0.21	--	--
G62.2		--	0.2	--	--
G70.3		<2	0.39	<0.04 (<0.002)	<0.05 (<0.002)
G72.2		<2	0.45	--	--
G80.3	A	--	1.1	--	--
G80.3	B	<2	0.68	--	--
G80.3	C	--	1.9	--	--
G80.3	D	<2	1.9	--	--
G80.3	V	<2	1.4	<0.04 (<0.002)	<0.1 (<0.01)
G80.8	V	<2	0.68	<0.05 (<0.002)	<0.04 (<0.002)
G81.4	V	<2	0.55	<0.04 (<0.002)	<0.04 (<0.002)
G82.2	A	--	0.86	--	--
G82.2	B	<2	0.78	--	--
G82.2	C	--	0.87	--	--
G82.2	D	<2	0.42	--	--
G82.2	V	<2	0.63	<0.04 (<0.002)	<0.04 (<0.002)
G83.0	V	<2	0.65	<0.04 (<0.002)	<0.04 (<0.002)
G90.3		<2	0.7	<0.04 (<0.002)	<0.04 (<0.002)
G92.2		<2	0.54	<0.04 (<0.002)	<0.04 (<0.002)
G100.3		--	0.69	--	--
G102.2		--	0.72	--	--
G110.3		<2	0.72	<0.04 (<0.002)	<0.05 (<0.002)
G112.2		<2	0.71	<0.04 (<0.002)	<0.04 (<0.002)
G120.3		<2	1.1	<0.04 (<0.002)	<0.04 (<0.002)
G122.2		<2	0.88	--	--

***Table A2**.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number		Cadmium Total	Total recoverable	ASTM		TCLP	
G130.3		--	0.51	--		--	
G132.2		--	1.1	--		--	
G140.3		--	0.6	<0.04	(<0.002)	<0.04	(<0.002)
G142.2		--	0.91	--		--	
G150.3		<2	1.3	<0.04	(<0.002)	<0.04	(<0.002)
G152.2		<2	0.68	--		--	
G160.3		<2	0.86	--		--	
G162.2		<2	0.98	--		--	
G170.3		<2	0.82	<0.04	(<0.002)	<0.04	(<0.002)
G172.2		<2	0.66	<0.04	(<0.002)	<0.04	(<0.002)
G180.3		<2	0.85	<0.04	(<0.002)	<0.04	(<0.002)
G182.2		<2	1.1	<0.04	(<0.002)	<0.04	(<0.002)
G190.08	V	<2	1.2	--		--	
G190.3		<2	1.1	<0.04	(<0.002)	<0.04	(<0.002)
G190.3	V	<2	0.96	--		--	
G191.0	V	<2	1.4	--		--	
G191.6	V	<2	1.4	--		--	
G192.2		<2	1.5	--		--	
G192.2	V	<2	1.5	--		--	
G200.3	A	<2	1.1	--		--	
G200.3	B	--	1.2	--		--	
G200.3	C	<2	1.1	--		--	
G200.3	D	--	1.1	--		--	
G200.3	V	<2	0.66	<0.04	(<0.002)	<0.04	(<0.002)
G200.8	V	<2	0.88	<0.04	(<0.002)	<0.04	(<0.002)
G201.8	A	<2	1	--		--	
G201.8	B	--	0.85	--		--	
G201.8	C	<2	0.93	--		--	
G201.8	D	--	1.1	--		--	
G201.8	V	<2	0.57	<0.04	(<0.002)	<0.04	(<0.002)
G203.0	V	<2	0.85	<0.04	(<0.002)	<0.04	(<0.002)
G205.1	V	<2	0.85	<0.04	(<0.002)	<0.04	(<0.002)
G210.3		--	1.1	--		--	
G212.2		--	1.5	--		--	
G220.3		<2	1.1	<0.04	(<0.002)	<0.04	(<0.002)
G222.2		<2	1.2	<0.04	(<0.002)	<0.04	(<0.002)

***Table A2.**--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number	Cadmium					
	Total	Total recoverable	ASTM		TCLP	
G230.3	<2	1.3	<0.04	(<0.002)	<0.04	(<0.002)
G232.2	<2	1.3	<0.04	(<0.002)	<0.04	(<0.002)
G240.3	<2	1.3	<0.04	(<0.002)	<0.06	(<0.003)
G242.2	<2	1.2	--		--	
G250.3	--	1.2	--		--	
G252.2	--	1.2	--		--	
G260.3	--	1.1	--		--	
G262.2	--	1.1	--		--	

Table A2.--*Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number	Chromium Total	Total recoverable	ASTM		TCLP	
G10.3	60	21.2	--		--	
G12.2	81	27.5	--		--	
G20.3	--	15.6	--		--	
G22.2	--	17.9	--		--	
G30.3	--	29.9	--		--	
G32.2	--	24.8	--		--	
G40.3	52	16.6	--		--	
G42.2	59	19.5	--		--	
G50.3	58	18.9	--		--	
G52.2	64	24.5	<0.1	(<0.005)	<0.1	(<0.005)
G60.3	--	6.25	--		--	
G62.2	--	2.6	--		--	
G70.3	35	9.59	<0.1	(<0.005)	<0.1	(<0.005)
G72.2	27	7.29	--		--	
G80.3 A	--	21.4	--		--	
G80.3 B	80	19.7	--		--	
G80.3 C	--	21.3	--		--	
G80.3 D	68	22.6	--		--	
G80.3 V	71	21.9	<0.1	(<0.005)	<0.1	(<0.005)
G80.8 V	94	18.4	<0.1	(<0.005)	<0.1	(<0.005)
G81.4 V	92	19.2	<0.1	(<0.005)	<0.1	(<0.005)
G82.2 A	--	25.8	--		--	
G82.2 B	85	28.3	--		--	
G82.2 C	--	23.6	--		--	
G82.2 D	76	26	--		--	
G82.2 V	79	26.1	<0.1	(<0.005)	<0.1	
G83.0 V	79	26.2	<0.1	(<0.005)	<0.1	(<0.005)
G90.3	58	22.4	<0.1	(<0.005)	<0.1	(<0.005)
G92.2	62	15.1	<0.1	(<0.005)	<0.1	(<0.005)
G100.3	--	16	--		--	
G102.2	--	20.6	--		--	
G110.3	64	23	<0.1	(<0.005)	<0.1	(<0.005)
G112.2	75	25.6	<0.05	(<0.002)	<0.1	(<0.005)
G120.3	61	21.4	<0.1	(<0.005)	<0.1	(<0.005)
G122.2	61	28.2	--		--	

***Table A2.**--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number		Chromium					
		Total	Total recoverable	ASTM		TCLP	
G130.3		--	17	--		--	
G132.2		--	32.8	--		--	
G140.3		--	19.2	<0.1	(<0.005)	<0.1	(<0.005)
G142.2		--	25.9	--		--	
G150.3		64	29	<0.1	(<0.005)	<0.1	(<0.005)
G152.2		68	23.7	--		--	
G160.3		65	25.9	--		--	
G162.2		69	25.5	--		--	
G170.3		54	19.9	<0.1	(<0.005)	<0.1	(<0.005)
G172.2		59	22	<0.1	(<0.005)	<0.1	(<0.005)
G180.3		72	27.1	<0.1	(<0.005)	<0.1	(<0.005)
G182.2		79	30.5	<0.1	(<0.005)	<0.1	(<0.005)
G190.08	V	45	20.2	--		--	
G190.3		54	20.7	<0.1	(<0.005)	<0.1	(<0.005)
G190.3	V	45	18.5	--		--	
G191.0	V	44	24.8	--		--	
G191.6	V	52	23.5	--		--	
G192.2		62	29.5	--		--	
G192.2	V	58	26.4	--		--	
G200.3	A	56	20.5	--		--	
G200.3	B	--	21.4	--		--	
G200.3	C	54	18.4	--		--	
G200.3	D	--	20.7	--		--	
G200.3	V	57	20.3	<0.1	(<0.005)	<0.1	(<0.005)
G200.8	V	56	21	<0.1	(<0.005)	<0.1	(<0.005)
G201.8	A	62	23.5	--		--	
G201.8	B	--	20.6	--		--	
G201.8	C	58	22.1	--		--	
G201.8	D	--	24.6	--		--	
G201.8	V	61	12.7	<0.2	(<0.01)	<0.1	(<0.005)
G203.0	V	59	28.9	<0.1	(<0.005)	<0.1	(<0.005)
G205.1	V	62	30.2	<0.1	(<0.005)	<0.1	(<0.005)
G210.3		--	23.5	--		--	
G212.2		--	28.7	--		--	
G220.3		49	21.5	<0.1	(<0.005)	<0.1	(<0.005)
G222.2		54	21.6	<0.1	(<0.005)	<0.1	(<0.005)

Table A2.--*Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number	Chromium					
	Total	Total recoverable	ASTM		TCLP	
G230.3	37	14.1	<0.1	(<0.005)	<0.1	(<0.005)
G232.2	41	15.2	<0.1	(<0.005)	<0.1	(<0.005)
G240.3	59	16.6	<0.1	(<0.005)	<0.1	(<0.005
G242.2	62	19.9	--		--	
G250.3	--	22	--		--	
G252.2	--	24.4	--		--	
G260.3	--	14.8	--		--	
G262.2	--	18.1	--		--	

***Table A2.**--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number		Copper					
		Total	Total recoverable	ASTM		TCLP	
G10.3		36	17.8	--		--	
G12.2		39	26.2	--		--	
G20.3		--	12.5	--		--	
G22.2		--	15.4	--		--	
G30.3		--	23.4	--		--	
G32.2		--	23.2	--		--	
G40.3		47	26.7	--		--	
G42.2		49	31.7	--		--	
G50.3		20	12.4	--		--	
G52.2		27	23.9	<0.4	(<0.02)	<0.4	(<0.02)
G60.3		--	21.3	--		--	
G62.2		--	12.7	--		--	
G70.3		48	27.1	<0.1	(<0.003)	<0.1	(<0.01)
G72.2		51	24.2	--		--	
G80.3	A	--	20.8	--		--	
G80.3	B	34	17.3	--		--	
G80.3	C	--	28.2	--		--	
G80.3	D	40	30.9	--		--	
G80.3	V	39	25	0.3	(0.01)	<0.1	(<0.003)
G80.8	V	35	15.2	<0.1	(<0.003)	<0.1	(<0.003)
G81.4	V	48	17.3	<0.1	(<0.003)	<0.1	(<0.004)
G82.2	A	--	24.3	--		--	
G82.2	B	34	25.7	--		--	
G82.2	C	--	25.1	--		--	
G82.2	D	29	24.9	--		--	
G82.2	V	39	26.4	<0.1	(<0.01)	<0.1	(<0.01)
G83.0	V	26	22.3	<0.1	(<0.01)	<0.1	(<0.003)
G90.3		73	54	<0.1	(<0.004)	<0.2	(<0.01)
G92.2		76	24.5	<0.1	(<0.003)	<0.1	(<0.01)
G100.3		--	8.62	--		--	
G102.2		--	10.8	--		--	
G110.3		28	13.1	<0.1	(<0.003)	<0.1	(<0.003)
G112.2		32	15.3	<0.1	(<0.01)	<0.1	(<0.003)
G120.3		23	13.7	<0.1	(<0.003)	<0.1	(<0.003)
G122.2		27	16	--		--	

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number		Copper					
		Total	Total recoverable	ASTM		TCLP	
G130.3		--	8.89	--		--	
G132.2		--	16.7	--		--	
G140.3		--	22.9	<0.1	(<0.003)	0.3	(0.01)
G142.2		--	14	--		--	
G150.3		36	22.2	<0.1	(<0.003)	<0.1	(<0.003)
G152.2		35	18	--		--	
G160.3		18	9.79	--		--	
G162.2		25	11.6	--		--	
G170.3		17	11.7	<0.1	(<0.003)	<0.1	(<0.003)
G172.2		18	12.2	<0.1	(<0.003)	<0.1	(<0.003)
G180.3		26	16.6	<0.1	(<0.003)	<0.1	(<0.01)
G182.2		30	18.2	<0.1	(<0.003)	<0.1	(<0.004)
G190.08	V	70	45.3	--		--	
G190.3		63	44	<0.1	(<0.003)	<0.1	(<0.003)
G190.3	V	76	55.6	--		--	
G191.0	V	83	54.8	--		--	
G191.6	V	76	52.1	--		--	
G192.2		66	53.6	--		--	
G192.2	V	68	56.6	--		--	
G200.3	A	19	12.3	--		--	
G200.3	B	--	14.3	--		--	
G200.3	C	19	13.6	--		--	
G200.3	D	--	14.8	--		--	
G200.3	V	22	13.8	<0.1	(<0.003)	<0.1	(<0.003)
G200.8	V	19	13.6	<0.1	(<0.003)	<0.04	(<0.002)
G201.8	A	21	14.1	--		--	
G201.8	B	--	11.6	--		--	
G201.8	C	20	15.8	--		--	
G201.8	D	--	16	--		--	
G201.8	V	22	8.86	<0.1	(<0.003)	<0.1	(<0.003)
G203.0	V	57	28.7	<0.1	(<0.003)	<0.2	(<0.01)
G205.1	V	38	28.4	<0.1	(<0.003)	<0.1	(<0.01)
G210.3		--	21	--		--	
G212.2		--	24.5	--		--	
G220.3		34	24.6	<0.1	(<0.004)	<0.1	(<0.003)
G222.2		35	25.2	<0.1	(<0.003)	0.2	(0.01)

Table A2.*--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number	Copper					
	Total	Total recoverable	ASTM		TCLP	
G230.3	38	21.8	<0.1	(<0.003)	<0.1	(<0.01)
G232.2	34	20.6	<0.1	(<0.003)	<0.1	(<0.005)
G240.3	39	19.6	<0.1	(<0.003)	<0.1	(<0.003)
G242.2	41	25.1	--		--	
G250.3	--	25.7	--		--	
G252.2	--	24.1	--		--	
G260.3	--	24.1	--		--	
G262.2	--	26.7	--		--	

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number		Nickel					
		Total	Total recoverable	ASTM		TCLP	
G10.3		28	17.7	--		--	
G12.2		27	20.4	--		--	
G20.3		--	19.2	--		--	
G22.2		--	19.4	--		--	
G30.3		--	25.1	--		--	
G32.2		--	20.6	--		--	
G40.3		24	12	--		--	
G42.2		22	13.3	--		--	
G50.3		24	14.9	--		--	
G52.2		23	17.5	<0.4	(<0.02)	<0.4	(<0.02)
G60.3		--	8	--		--	
G62.2		--	6	--		--	
G70.3		19	10.1	<0.2	(<0.01)	<0.2	(<0.01)
G72.2		16	8.6	--		--	
G80.3	A	--	19.5	--		--	
G80.3	B	32	17.5	--		--	
G80.3	C	--	18.3	--		--	
G80.3	D	27	20	--		--	
G80.3	V	31	20.7	<0.2	(<0.01)	<0.2	(<0.01)
G80.8	V	32	17	<0.3	(<0.02)	<0.3	(<0.02)
G81.4	V	39	17.6	<0.2	(<0.01)	<0.2	(<0.01)
G82.2	A	--	22	--		--	
G82.2	B	32	22.9	--		--	
G82.2	C	--	20.9	--		--	
G82.2	D	29	22.3	--		--	
G82.2	V	31	22.8	<0.2	(<0.01)	<0.2	(<0.01)
G83.0	V	28	22	<0.2	(<0.01)	<0.3	(<0.02)
G90.3		23	15.6	<0.2	(<0.01)	<0.2	(<0.01)
G92.2		27	9.9	<0.2	(<0.01)	<0.2	(<0.01)
G100.3		--	10.6	--		--	
G102.2		--	14.6	--		--	
G110.3		27	17.2	<0.2	(<0.01)	<0.2	(<0.01)
G112.2		29	16.5	<0.2	(<0.01)	<0.2	(<0.01)
G120.3		21	16.5	<0.2	(<0.01)	<0.2	(<0.01)
G122.2		26	16	--		--	

Table A2.--*Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number		Nickel					
		Total	Total recoverable	ASTM		TCLP	
G130.3		--	7.9	--		--	
G132.2		--	16.1	--		--	
G140.3		--	12.4	<0.2	(<0.01)	<0.3	(<0.01)
G142.2		--	15.5	--		--	
G150.3		27	21	<0.2	(<0.01)	<0.2	(<0.01)
G152.2		26	12.6	--		--	
G160.3		24	13	--		--	
G162.2		29	14.1	--		--	
G170.3		21	117	<0.2	(<0.01)	<0.2	(<0.01)
G172.2		23	16.5	<0.2	(<0.01)	<0.2	(<0.01)
G180.3		25	17.6	<0.2	(<0.01)	<0.2	(<0.01)
G182.2		28	19	<0.2	(<0.01)	<0.2	(<0.01)
G190.08	V	19	10.4	--		--	
G190.3		21	15.6	<0.2	(<0.01)	<0.2	(<0.01)
G190.3	V	19	12	--		--	
G191.0	V	19	13.4	--		--	
G191.6	V	18	14.3	--		--	
G192.2		24	20.4	--		--	
G192.2	V	21	14.2	--		--	
G200.3	A	21	16.3	--		--	
G200.3	B	--	16.5	--		--	
G200.3	C	20	15.7	--		--	
G200.3	D	--	16.6	--		--	
G200.3	V	21	15.6	<0.2	(<0.01)	<0.2	(<0.01)
G200.8	V	20	15	<0.2	(<0.01)	<0.2	(<0.01)
G201.8	A	22	16.3	--		--	
G201.8	B	--	14.1	--		--	
G201.8	C	22	17.4	--		--	
G201.8	D	--	16.7	--		--	
G201.8	V	23	9.9	<0.2	(<0.01)	<0.2	(<0.01)
G203.0	V	26	22.4	<0.2	(<0.01)	<0.2	(<0.01)
G205.1	V	29	21.5	<0.2	(<0.01)	<0.2	(<0.01)
G210.3		--	15	--		--	
G212.2		--	18.2	--		--	
G220.3		24	20.8	<0.2	(<0.01)	<0.2	(<0.01)
G222.2		24	21.6	<0.2	(<0.01)	<0.2	(<0.01)

***Table A2.**--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number	Nickel					
	Total	Total recoverable	ASTM		TCLP	
G230.3	18	13.8	<0.2	(<0.01)	<0.2	(<0.01)
G232.2	18	15.7	<0.2	(<0.01)	<0.2	(<0.01)
G240.3	27	19	<0.2	(<0.01)	<0.2	(<0.01)
G242.2	29	19.5	--		--	
G250.3	--	17.6	--		--	
G252.2	--	20.4	--		--	
G260.3	--	17.7	--		--	
G262.2	--	17.1	--		--	

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number		Lead					
		Total	Total recoverable	ASTM		TCLP	
G10.3		14	6.7	--		--	
G12.2		12	9.9	--		--	
G20.3		--	5.9	--		--	
G22.2		--	5	--		--	
G30.3		--	14	--		--	
G32.2		--	8.6	--		--	
G40.3		17	6.7	--		--	
G42.2		14	8.7	--		--	
G50.3		15	12	--		--	
G52.2		15	13	<0.4	(0.02)	<0.4	(0.02)
G60.3		--	2	--		--	
G62.2		--	2	--		--	
G70.3		13	6	<0.1	(<0.003)	<0.1	(<0.004)
G72.2		12	3.3	--		--	
G80.3	A	--	13	--		--	
G80.3	B	23	10	--		--	
G80.3	C	--	30	--		--	
G80.3	D	30	21.1	--		--	
G80.3	V	29	17.8	<0.03	(<0.002)	<0.05	(<0.002)
G80.8	V	19	5.8	<0.02	(<0.001)	<0.1	(<0.003)
G81.4	V	19	6.9	<0.02	(<0.001)	<0.1	(<0.004)
G82.2	A	--	7.7	--		--	
G82.2	B	32	8	--		--	
G82.2	C	--	10	--		--	
G82.2	D	15	8.3	--		--	
G82.2	V	18	10.5	<0.02	(<0.001)	<0.1	(<0.003)
G83.0	V	17	7.47	<0.02	(<0.001)	<0.03	(<0.002)
G90.3		18	14	<0.02	(<0.001)	<0.03	(<0.001)
G92.2		15	5.6	<0.1	(<0.003)	<0.02	(<0.001)
G100.3		--	8	--		--	
G102.2		--	6.6	--		--	
G110.3		17	10.4	<0.02	(<0.001)	<0.04	(<0.002)
G112.2		15	7.97	<0.02	(<0.001)	<0.05	(<0.002)
G120.3		17	14	<0.1	(<0.003)	<0.05	(<0.002)
G122.2		17	9.7	--		--	

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number		Lead					
		Total	Total recoverable	ASTM		TCLP	
G130.3		--	9.5	--		--	
G132.2		--	7.8	--		--	
G140.3		--	54	<0.02	(<0.001)	0.2	(0.01)
G142.2		--	10	--		--	
G150.3		20	10.4	<0.02	(<0.001)	<0.04	(<0.002)
G152.2		18	7.7	--		--	
G160.3		18	6.8	--		--	
G162.2		13	4.2	--		--	
G170.3		20	16.3	<0.02	(<0.001)	<0.04	(<0.002)
G172.2		15	11.1	<0.02	(<0.001)	<0.1	(<0.003)
G180.3		15	13.9	<0.02	(<0.001)	<0.04	(<0.002)
G182.2		16	11	<0.03	(<0.001)	<0.02	(<0.001)
G190.08	V	17	13	--		--	
G190.3		17	14.2	<0.02	(<0.001)	<0.1	(<0.003)
G190.3	V	15	14.1	--		--	
G191.0	V	14	9.2	--		--	
G191.6	V	15	7.6	--		--	
G192.2		14	9.6	--		--	
G192.2	V	15	7.7	--		--	
G200.3	A	18	11	--		--	
G200.3	B	--	12	--		--	
G200.3	C	17	11	--		--	
G200.3	D	--	10	--		--	
G200.3	V	18	14.5	<0.02	(<0.001)	<0.02	(<0.001)
G200.8	V	17	12.7	<0.02	(<0.001)	<0.02	(<0.001)
G201.8	A	17	9.2	--		--	
G201.8	B	--	8.1	--		--	
G201.8	C	15	11	--		--	
G201.8	D	--	10	--		--	
G201.8	V	18	6.27	<0.02	(<0.001)	<0.05	(<0.002)
G203.0	V	17	16	<0.02	(<0.001)	<0.03	(<0.002)
G205.1	V	18	12.4	<0.03	(<0.002)	<0.04	(<0.002)
G210.3		--	16	--		--	
G212.2		--	14	--		--	
G220.3		25	19	<0.04	(<0.002)	<0.02	(<0.001)
G222.2		18	14.9	<0.02	(<0.001)	<0.1	(<0.004)

Table A2.--*Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number	Lead					
	Total	Total recoverable	ASTM		TCLP	
G230.3	27	18	<0.02	(<0.001)	<0.1	(<0.004)
G232.2	15	7.8	<0.1	(<0.003)	<0.1	(<0.003)
G240.3	21	9.6	0.4	(0.02)	<0.04	(<0.002)
G242.2	13	8.9	--		--	
G250.3	--	7.8	--		--	
G252.2	--	7.1	--		--	
G260.3	--	8.7	--		--	
G262.2	--	4.7	--		--	

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number		Zinc					
		Total	Total recoverable	ASTM		TCLP	
G10.3		140	85.5	--		--	
G12.2		130	82.1	--		--	
G20.3		--	65.2	--		--	
G22.2		--	50.8	--		--	
G30.3		--	123	--		--	
G32.2		--	63	--		--	
G40.3		130	78.9	--		--	
G42.2		120	75.3	--		--	
G50.3		120	95	--		--	
G52.2		94	74	0.4	(0.02)	1.3	(0.06)
G60.3		--	29.7	--		--	
G62.2		--	13.1	--		--	
G70.3		76	40.1	0.5	(0.03)	3.3	(0.17)
G72.2		64	27.8	--		--	
G80.3	A	--	88	--		--	
G80.3	B	120	70.1	--		--	
G80.3	C	--	193	--		--	
G80.3	D	210	162	--		--	
G80.3	V	200	138	0.8	(0.04)	6.6	(0.33)
G80.8	V	100	54.1	0.3	(0.01)	3.5	(0.18)
G81.4	V	110	51.5	0.5	(0.02)	2.5	(0.13)
G82.2	A	--	64.4	--		--	
G82.2	B	88	66.7	--		--	
G82.2	C	--	74.8	--		--	
G82.2	D	86	68.1	--		--	
G82.2	V	89	66.6	0.6	(0.03)	4.2	(0.2)
G83.0	V	83	66.4	0.5	(0.03)	3.3	(0.16)
G90.3		120	84.7	0.1	(0.007)	2.6	(0.13)
G92.2		110	47.6	0.2	(0.01)	1.2	(0.06)
G100.3		--	67.4	--		--	
G102.2		--	71.5	--		--	
G110.3		130	82.4	0.7	(0.03)	2.9	(0.14)
G112.2		110	64	0.6	(0.03)	3.1	(0.15)
G120.3		99	80.1	0.9	(0.05)	3.7	(0.19)
G122.2		96	66.9	--		--	

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number		Zinc					
		Total	Total recoverable	ASTM		TCLP	
G130.3		--	55.3	--		--	
G132.2		--	73.3	--		--	
G140.3		--	79.6	0.6	(0.03)	3.2	(0.16)
G142.2		--	67	--		--	
G150.3		98	73.9	0.7	(0.04)	4	(0.2)
G152.2		120	63.5	--		--	
G160.3		110	58.2	--		--	
G162.2		100	55.5	--		--	
G170.3		120	102	0.7	(0.03)	3.2	(0.16)
G172.2		100	87.5	0.7	(0.04)	2.8	(0.14)
G180.3		110	92.1	0.6	(0.03)	3.8	(0.19)
G182.2		110	89	0.1	(0.01)	2.9	(0.15)
G190.08	V	86	82.2	--		--	
G190.3		93	79.1	0.7	(0.03)	5.8	(0.29)
G190.3	V	88	78	--		--	
G191.0	V	86	70.4	--		--	
G191.6	V	73	69.7	--		--	
G192.2		67	58.8	--		--	
G192.2	V	74	61.5	--		--	
G200.3	A	120	90.1	--		--	
G200.3	B	--	98.1	--		--	
G200.3	C	120	89.7	--		--	
G200.3	D	--	84.5	--		--	
G200.3	V	110	83.3	<0.1	(<0.004)	2.6	(0.13)
G200.8	V	110	89	0.1	(0.01)	2.5	(0.13)
G201.8	A	100	83.8	--		--	
G201.8	B	--	88.9	--		--	
G201.8	C	100	83.5	--		--	
G201.8	D	--	87.4	--		--	
G201.8	V	100	46.3	<0.1	(<0.004)	2.6	(0.13)
G203.0	V	100	91.3	0.3	(0.01)	4.9	(0.25)
G205.1	V	100	85	0.5	(0.03)	3	(0.15)
G210.3		--	76.1	--		--	
G212.2		--	60.1	--		--	
G220.3		120	98.8	0.2	(0.01)	2.2	(0.11)
G222.2		110	84.6	0.3	(0.02)	6.5	(0.33)

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number	Zinc					
	Total	Total recoverable	ASTM		TCLP	
G230.3	130	100	0.7	(0.04)	3.9	(0.19)
G232.2	110	85	0.2	(0.008)	3.7	(0.19)
G240.3	160	98.6	0.6	(0.03)	2.6	(0.13)
G242.2	130	95.7	--		--	
G250.3	--	96.4	--		--	
G252.2	--	88	--		--	
G260.3	--	100	--		--	
G262.2	--	94.6	--		--	

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number		Selenium					
		Total	Total recoverable	ASTM		TCLP	
G10.3		--	<5	--		--	
G12.2		--	<1	--		--	
G20.3		--	<5.2	--		--	
G22.2		--	<1	--		--	
G30.3		--	<5	--		--	
G32.2		--	<1	--		--	
G40.3		--	<5	--		--	
G42.2		--	<1	--		--	
G50.3		--	<5	--		--	
G52.2		--	<1	<1	(<0.05)	<1	(<0.05)
G60.3		--	<5	--		--	
G62.2		--	<5	--		--	
G70.3		--	<0.19	<0.04	(<0.002)	<0.04	(<0.002)
G72.2		--	<5	--		--	
G80.3	A	--	<5	--		--	
G80.3	B	--	<5	--		--	
G80.3	C	--	<5	--		--	
G80.3	D	--	<5	--		--	
G80.3	V	--	<0.19	<0.04	(<0.002)	<0.04	(<0.002)
G80.8	V	--	<0.19	<0.04	(<0.002)	<0.04	(<0.002)
G81.4	V	--	<5	<0.04	(<0.002)	<0.04	(<0.002)
G82.2	A	--	<5.9	--		--	
G82.2	B	--	<5	--		--	
G82.2	C	--	<5	--		--	
G82.2	D	--	<5	--		--	
G82.2	V	--	<0.19	<0.04	(<0.002)	<0.04	(<0.002)
G83.0	V	--	<0.19	<0.04	(<0.002)	<0.04	(<0.002)
G90.3		--	<5	<0.04	(<0.002)	<0.04	(<0.002)
G92.2		--	<5	<0.04	(<0.002)	<0.04	(<0.002)
G100.3		--	<5	--		--	
G102.2		--	<5	--		--	
G110.3		--	<0.19	<0.04	(<0.002)	<0.04	(<0.002)
G112.2		--	<0.2	<0.04	(<0.002)	<0.04	(<0.002)
G120.3		--	<0.19	<0.04	(<0.002)	<0.04	(<0.002)
G122.2		--	<5	--		--	

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number		Selenium					
		Total	Total recoverable	ASTM		TCLP	
G130.3		--	<5.2	--		--	
G132.2		--	<6.6	--		--	
G140.3		--	<0.2	<0.04	(<0.002)	<0.04	(<0.002)
G142.2		--	<7	--		--	
G150.3		--	<0.2	<0.04	(<0.002)	<0.04	(<0.002)
G152.2		--	<0.5	--		--	
G160.3		--	<8.8	--		--	
G162.2		--	<0.5	--		--	
G170.3		--	<0.17	<0.04	(<0.002)	<0.04	(<0.002)
G172.2		--	<0.19	<0.04	(<0.002)	<0.04	(<0.002)
G180.3		--	<5	<0.04	(<0.002)	<0.04	(<0.002)
G182.2		--	<5	<0.04	(<0.002)	<0.04	(<0.002)
G190.08	V	--	<8.4	--		--	
G190.3		--	<0.15	<0.04	(<0.002)	<0.04	(<0.002)
G190.3	V	--	<5	--		--	
G191.0	V	--	<5	--		--	
G191.6	V	--	<5	--		--	
G192.2		--	<5.4	--		--	
G192.2	V	--	<5	--		--	
G200.3	A	--	<5	--		--	
G200.3	B	--	<5	--		--	
G200.3	C	--	<5	--		--	
G200.3	D	--	<5	--		--	
G200.3	V	--	<5.6	<0.04	(<0.002)	<0.04	(<0.002)
G200.8	V	--	<0.5	<0.04	(<0.002)	<0.04	(<0.002)
G201.8	A	--	<5	--		--	
G201.8	B	--	<5	--		--	
G201.8	C	--	<5	--		--	
G201.8	D	--	<5	--		--	
G201.8	V	--	<6.4	<0.04	(<0.002)	<0.04	(<0.002)
G203.0	V	--	<5	<0.04	(<0.002)	<0.04	(<0.002)
G205.1	V	--	<0.19	<0.04	(<0.002)	<0.04	(<0.002)
G210.3		--	<5	--		--	
G212.2		--	<6.8	--		--	
G220.3		--	<5	<0.04	(<0.002)	<0.04	(<0.002)
G222.2		--	<5	<0.04	(<0.002)	<0.04	(<0.002)

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number	Selenium					
	Total	Total recoverable	ASTM		TCLP	
G230.3	--	<5	<0.04	(<0.002)	<0.04	(<0.002)
G232.2	--	<5	<0.04	(<0.002)	<0.04	(<0.002)
G240.3	--	<0.19	<0.04	(<0.002)	<0.04	(<0.002)
G242.2	--	<6.1	--		--	
G250.3	--	<5	--		--	
G252.2	--	<5	--		--	
G260.3	--	<5	--		--	
G262.2	--	<5	--		--	

Table A2.*--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number		Thallium					
		Total	Total recoverable	ASTM		TCLP	
G10.3		--	<9.1	--		--	
G12.2		--	<5	--		--	
G20.3		--	<5	--		--	
G22.2		--	<5	--		--	
G30.3		--	<5	--		--	
G32.2		--	<5	--		--	
G40.3		--	<7.2	--		--	
G42.2		--	<5	--		--	
G50.3		--	<6.4	--		--	
G52.2		--	<5	<0.4	(<0.02)	<0.4	(<0.02)
G60.3		--	<5	--		--	
G62.2		--	<5.8	--		--	
G70.3		--	<0.5	<1	(<0.05)	<1	(<0.05)
G72.2		--	<5	--		--	
G80.3	A	--	<5	--		--	
G80.3	B	--	<7	--		--	
G80.3	C	--	<5	--		--	
G80.3	D	--	<5	--		--	
G80.3	V	--	<5	<1	(<0.05)	<1	(<0.05)
G80.8	V	--	<5	<1	(<0.05)	<0.8	(<0.04)
G81.4	V	--	<6.8	<1	(<0.05)	<1	(<0.05)
G82.2	A	--	<6	--		--	
G82.2	B	--	<5	--		--	
G82.2	C	--	<8.7	--		--	
G82.2	D	--	<6.4	--		--	
G82.2	V	--	<6.1	<1	(<0.05)	<1	(<0.05)
G83.0	V	--	<14	<1	(<0.05)	<1	(<0.05)
G90.3		--	<5.4	<1	(<0.05)	<1	(<0.05)
G92.2		--	<5.6	<1	(<0.05)	<1	(<0.05)
G100.3		--	<6.9	--		--	
G102.2		--	<5	--		--	
G110.3		--	<5	<1	(<0.05)	<1	(<0.05)
G112.2		--	<5.1	<1	(<0.05)	<1	(<0.05)
G120.3		--	<5	<1	(<0.05)	<1	(<0.05)
G122.2		--	<5.4	--		--	

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number		Thallium					
		Total	Total recoverable	ASTM		TCLP	
G130.3		--	<5	--		--	
G132.2		--	<5	--		--	
G140.3		--	<11	<1	(<0.05)	<1	(<0.05)
G142.2		--	<8.6	--		--	
G150.3		--	<5	<1	(<0.05)	<1	(<0.05)
G152.2		--	<5.7	--		--	
G160.3		--	<9.1	--		--	
G162.2		--	<6.5	--		--	
G170.3		--	<5	<1	(<0.05)	<1	(<0.05)
G172.2		--	<0.5	<1	(<0.05)	<1	(<0.05)
G180.3		--	<5	<1	(<0.05)	<1	(<0.05)
G182.2		--	<7.3	<1	(<0.05)	<1	(<0.05)
G190.08	V	--	<8	--		--	
G190.3		--	<0.5	<1	(<0.05)	<1	(<0.05)
G190.3	V	--	<8.1	--		--	
G191.0	V	--	<0.5	--		--	
G191.6	V	--	<0.5	--		--	
G192.2		--	<5	--		--	
G192.2	V	--	<5	--		--	
G200.3	A	--	<5	--		--	
G200.3	B	--	<5	--		--	
G200.3	C	--	<5	--		--	
G200.3	D	--	<5	--		--	
G200.3	V	--	<5	<1	(<0.05)	<1	(<0.05)
G200.8	V	--	<5	<1	(<0.05)	<1	(<0.05)
G201.8	A	--	<5	--		--	
G201.8	B	--	<11	--		--	
G201.8	C	--	<5	--		--	
G201.8	D	--	<5	--		--	
G201.8	V	--	<5	<1	(<0.05)	<1	(<0.05)
G203.0	V	--	<13	<1	(<0.05)	<1	(<0.05)
G205.1	V	--	<8.1	<1	(<0.05)	<1	(<0.05)
G210.3		--	<5	--		--	
G212.2		--	<5	--		--	
G220.3		--	<5	<1	(<0.05)	<1	(<0.05)
G222.2		--	<12	<1	(<0.05)	<1	(<0.05)

Table A2.--*Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number	Thallium					
	Total	Total recoverable	ASTM		TCLP	
G230.3	--	<5	<1	(<0.05)	<1	(<0.05)
G232.2	--	<5	<1	(<0.05)	<1	(<0.05)
G240.3	--	<14	<1	(<0.05)	<1	(<0.05)
G242.2	--	<9.9	--		--	
G250.3	--	<5.3	--		--	
G252.2	--	<5	--		--	
G260.3	--	<5	--		--	
G262.2	--	<10	--		--	

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number		Mercury			
		Total	Total recoverable	ASTM	TCLP
G10.3		--	<0.022	--	--
G12.2		--	0.019	--	--
G20.3		--	<0.024	--	--
G22.2		--	0.018	--	--
G30.3		--	<0.038	--	--
G32.2		--	0.025	--	--
G40.3		--	<0.043	--	--
G42.2		--	0.042	--	--
G50.3		--	<0.041	--	--
G52.2		--	0.05	0.03 (<0.0002)	<0.001 (<0.00005)
G60.3		--	<0.022	--	--
G62.2		--	<0.005	--	--
G70.3		--	<0.033	<0.001 (<0.00005)	<0.001 (<0.00005)
G72.2		--	<0.029	--	--
G80.3	A	--	<0.041	--	--
G80.3	B	--	<0.029	--	--
G80.3	C	--	<0.03	--	--
G80.3	D	--	<0.04	--	--
G80.3	V	--	<0.04	<0.001 (<0.00005)	<0.001 (<0.00005)
G80.8	V	--	<0.024	<0.001 (<0.00005)	<0.001 (<0.00006)
G81.4	V	--	<0.025	<0.001 (<0.00005)	<0.001 (<0.00005)
G82.2	A	--	0.0706	--	--
G82.2	B	--	0.0749	--	--
G82.2	C	--	0.07	--	--
G82.2	D	--	0.08	--	--
G82.2	V	--	0.0696	<0.001 (<0.00005)	<0.001 (<0.00005)
G83.0	V	--	<0.029	<0.001 (<0.00005)	<0.001 (<0.00005)
G90.3		--	<0.038	<0.001 (<0.00005)	<0.001 (<0.00005)
G92.2		--	<0.019	<0.001 (<0.00005)	<0.001 (<0.00005)
G100.3		--	<0.03	--	--
G102.2		--	0.04	--	--
G110.3		--	0.04	<0.001 (<0.00005)	<0.001 (<0.00005)
G112.2		--	0.02	<0.001 (<0.00005)	<0.001 (<0.00005)
G120.3		--	0.04	<0.001 (<0.00005)	<0.001 (<0.00005)
G122.2		--	0.02	--	--

Table A2.--*Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number	Mercury			
	Total	Total recoverable	ASTM	TCLP
G130.3	--	0.03	--	--
G132.2	--	0.01	--	--
G140.3	--	0.04	<0.001 (<0.00005)	<0.001 (<0.00007)
G142.2	--	0.02	--	--
G150.3	--	0.03	<0.001 (<0.00005)	<0.001 (<0.00005)
G152.2	--	0.03	--	--
G160.3	--	0.05	--	--
G162.2	--	0.03	--	--
G170.3	--	0.03	<0.001 (<0.00005)	<0.001 (<0.00005)
G172.2	--	0.01	<0.001 (<0.00005)	<0.001 (<0.00005)
G180.3	--	<0.039	<0.001 (<0.00005)	<0.001 (<0.00005)
G182.2	--	<0.027	<0.001 (<0.00005)	<0.001 (<0.00005)
G190.08 V	--	0.02	--	--
G190.3	--	0.02	<0.001 (<0.00005)	<0.001 (<0.00005)
G190.3 V	--	0.03	--	--
G191.0 V	--	<0.035	--	--
G191.6 V	--	0.01	--	--
G192.2	--	0.005	--	--
G192.2 V	--	0.02	--	--
G200.3 A	--	<0.027	--	--
G200.3 B	--	<0.033	--	--
G200.3 C	--	0.03	--	--
G200.3 D	--	0.02	--	--
G200.3 V	--	<0.033	<0.001 (<0.00005)	<0.001 (<0.00005)
G200.8 V	--	<0.024	<0.001 (<0.00005)	<0.001 (<0.00005)
G201.8 A	--	<0.028	--	--
G201.8 B	--	<0.016	--	--
G201.8 C	--	0.02	--	--
G201.8 D	--	<0.025	--	--
G201.8 V	--	<0.028	<0.001 (<0.00005)	<0.001 (<0.00005)
G203.0 V	--	<0.034	<0.001 (<0.00005)	<0.001 (<0.00005)
G205.1 V	--	0.02	<0.001 (<0.00005)	<0.001 (<0.00005)
G210.3	--	0.02	--	--
G212.2	--	0.03	--	--
G220.3	--	<0.033	<0.001 (<0.00005)	<0.001 (<0.00005)
G222.2	--	<0.031	<0.001 (<0.00005)	<0.001 (0.00005)

Table A2.--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued

Sample number	Mercury					
	Total	Total recoverable	ASTM		TCLP	
G230.3	--	<0.029	<0.001	(<0.00005)	<0.001	(<0.00005)
G232.2	--	<0.0094	<0.001	(<0.00005)	<0.001	(<0.00005)
G240.3	--	<0.037	<0.001	(<0.00005)	<0.001	(<0.00005)
G242.2	--	0.004	--		--	
G250.3	--	0.02	--		--	
G252.2	--	0.005	--		--	
G260.3	--	<0.029	--		--	
G262.2	--	<0.015	--		--	

Table A2.*--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number		Antimony					
		Total	Total recoverable	ASTM		TCLP	
G10.3		--	5.2	--		--	
G12.2		--	<3	--		--	
G20.3		--	<3	--		--	
G22.2		--	<3	--		--	
G30.3		--	<3	--		--	
G32.2		--	<3	--		--	
G40.3		--	<3	--		--	
G42.2		--	<3	--		--	
G50.3		--	<3	--		--	
G52.2		--	<3	<0.4	(<0.02)	<0.4	(<0.02)
G60.3		--	<3	--		--	
G62.2		--	<3	--		--	
G70.3		--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G72.2		--	<3	--		--	
G80.3	A	--	<3	--		--	
G80.3	B	--	<3	--		--	
G80.3	C	--	<3	--		--	
G80.3	D	--	<3	--		--	
G80.3	V	--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G80.8	V	--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G81.4	V	--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G82.2	A	--	<3	--		--	
G82.2	B	--	<3	--		--	
G82.2	C	--	<3	--		--	
G82.2	D	--	<3	--		--	
G82.2	V	--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G83.0	V	--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G90.3		--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G92.2		--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G100.3		--	<3	--		--	
G102.2		--	<3	--		--	
G110.3		--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G112.2		--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G120.3		--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G122.2		--	<3	--		--	

Table A2.--*Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number		Antimony					
		Total	Total recoverable	ASTM		TCLP	
G130.3		--	<3	--		--	
G132.2		--	<3	--		--	
G140.3		--	<3.2	<0.6	(<0.03)	<0.6	(<0.03)
G142.2		--	<3	--		--	
G150.3		--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G152.2		--	<3	--		--	
G160.3		--	<3	--		--	
G162.2		--	<3	--		--	
G170.3		--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G172.2		--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G180.3		--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G182.2		--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G190.08	V	--	<3	--		--	
G190.3		--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G190.3	V	--	<3	--		--	
G191.0	V	--	<3	--		--	
G191.6	V	--	<3	--		--	
G192.2		--	<3	--		--	
G192.2	V	--	<3	--		--	
G200.3	A	--	<3	--		--	
G200.3	B	--	<3	--		--	
G200.3	C	--	<3	--		--	
G200.3	D	--	<3	--		--	
G200.3	V	--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G200.8	V	--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G201.8	A	--	<3	--		--	
G201.8	B	--	<3	--		--	
G201.8	C	--	<3	--		--	
G201.8	D	--	<4.3	--		--	
G201.8	V	--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G203.0	V	--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G205.1	V	--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G210.3		--	<3	--		--	
G212.2		--	<3	--		--	
G220.3		--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G222.2		--	<3	<0.6	(<0.03)	<0.6	(<0.03)

Table A2.*--Concentrations of metals in soil samples analyzed by different laboratory methods in Clark County, Wash.--Continued*

Sample number	Antimony					
	Total	Total recoverable	ASTM		TCLP	
G230.3	--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G232.2	--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G240.3	--	<3	<0.6	(<0.03)	<0.6	(<0.03)
G242.2	--	<3	--		--	
G250.3	--	<4.3	--		--	
G252.2	--	<3.8	--		--	
G260.3	--	<3	--		--	
G262.2	--	<3.4	--		--	

Table A3.--Organic and inorganic carbon content of soil samples in Clark County, Wash.
[Concentrations of carbon are in percent of dry soil; concentrations of TPH (Total Petroleum Hydrocarbons) are in milligrams per kilogram (mg/kg) of dry soil; concentrations of PCB's (Polychlorinated Biphenyls) are in micrograms per kilogram (µg/kg) of dry soil; --, no data]

Sample number		Carbon Total (percent)	Carbon Organic (percent)	Carbon Inorganic (percent)	TPH (mg/kg)	PCB's (µg/kg)
G10.3		1.31	1.31	<0.01	--	--
G12.2		0.9	0.9	<0.01	--	--
G40.3		1.64	1.64	<0.01	--	--
G42.2		1.81	1.81	<0.01	--	--
G50.3		1.01	1.01	<0.01	--	--
G52.2		0.67	0.67	<0.01	--	--
G70.3		1.89	1.89	<0.01	--	--
G72.2		0.55	0.55	<0.01	--	--
G80.3	A	--	--	--	<40	<52
G80.3	B	1.91	1.91	<0.01	--	--
G80.3	D	1.06	1.06	<0.01	--	--
G80.3	V	2.46	2.46	<0.01	--	--
G80.8	V	0.98	0.98	<0.01	--	--
G81.4	V	0.83	0.83	<0.01	--	--
G82.2	B	0.7	0.7	<0.01	--	--
G82.2	D	0.51	0.51	<0.01	--	--
G82.2	V	0.74	0.74	<0.01	--	--
G83.0	V	0.72	0.72	<0.01	--	--
G90.3		2.92	2.92	<0.01	--	--
G92.2		1.48	1.48	<0.01	--	--
G110.3		3.12	3.1	<0.02	--	--
G112.2		0.52	0.52	<0.01	--	--
G120.3		2.56	2.54	<0.02	<40	<52
G122.2		0.52	0.52	<0.01	--	--
G150.3		1.41	1.41	<0.01	--	--
G152.2		1.94	1.94	<0.01	--	--
G160.3		2.52	2.52	<0.01	--	--
G162.2		1.14	1.14	<0.01	--	--
G170.3		1.96	1.95	<0.01	--	--
G172.2		0.41	0.41	<0.01	--	--
G180.3		3.6	3.58	<0.02	--	--
G182.2		1.11	1.11	<0.01	--	--

Table A3.--Organic and inorganic carbon content of soil samples in Clark County, Wash.--Continued

Sample number		Carbon Total (percent)	Carbon Organic (percent)	Carbon Inorganic (percent)	TPH (mg/kg)	PCB's (µg/kg)
G190.08	V	5.62	5.62	<0.01	--	--
G190.3		5.08	5.08	<0.01	--	--
G190.3	V	5.82	5.82	<0.01	--	--
G191.0	V	4.79	4.77	0.02	--	--
G191.6	V	2.5	2.5	<0.01	--	--
G192.2		0.82	0.82	<0.01	--	--
G192.2	V	1.38	1.38	<0.01	--	--
G200.3	A	1.68	1.68	<0.01	--	--
G200.3	B	--	--	--	<40	<97
G200.3	C	1.6	1.6	<0.01	--	--
G200.3	V	1.72	1.72	<0.01	--	--
G200.8	V	1.5	1.5	<0.01	--	--
G201.8	A	0.48	0.48	<0.01	--	--
G201.8	C	0.32	0.32	<0.01	--	--
G201.8	V	0.37	0.37	<0.01	--	--
G203.0	V	0.12	0.12	<0.01	--	--
G205.1	V	0.14	0.14	<0.01	--	--
G220.3		6.79	6.75	0.04	--	--
G222.2		4.59	4.56	0.03	--	--
G230.3		7.02	6.98	0.04	--	--
G232.2		3.51	3.51	<0.01	--	--
G240.3		4.07	4.04	0.03	--	--
G242.2		1.18	1.18	<0.01	--	--
G250.3		--	--	--	<40	<53
G260.3		--	--	--	<40	<49
G262.2		--	--	--	<40	<51

__Table A4.__--pH and electrical conductivity of soil solutions in Clark County, Wash.
[1:1, pH values determined using 1:1 mixture by weight of soil and deionized water; $CaCl_2$, pH values determined after the addition of 1 milliliter, 1 molar $CaCl_2$ solution to the soil-water mixture; units for electrical conductivity are in microsiemens per centimeter and units of water content are in percent by weight of dry soil; --, no data]

Sample number	pH		Electrical conductivity	Water content
	1:1	$CaCl_2$		
G10.3	5.5	5.1	85	--
G12.2	6.0	5.1	--	--
G20.3	6.5	5.9	46	--
G22.2	5.9	5.0	--	--
G30.3	5.6	5.3	161	--
G32.2	6.0	5.3	--	--
G40.3	5.8	5.2	36	--
G42.2	6.0	4.7	--	--
G50.3	5.5	5.1	168	--
G52.2	5.2	4.4	--	--
G60.3	5.4	4.9	71	--
G62.2	5.7	5.5	9	--
G70.3	5.2	4.9	299	--
G72.2	6.0	5.2	42	--
G80.3 A	5.3	5.0	226	--
G80.3 B	4.7	4.6	253	--
G80.3 C	5.2	5.1	269	--
G80.3 D	5.6	5.0	83	--
G80.3 V	5.6	5.1	218	--
G80.8 V	6.0	5.1	47	--
G81.4 V	6.0	5.3	11	--
G82.2 A	5.4	5.5	75	--
G82.2 B	6.0	5.6	100	--
G82.2 C	5.8	5.5	109	--
G82.2 D	6.0	5.5	41	--
G82.2 V	6.2	5.5	62	--
G83.0 V	6.2	5.6	56	--
G90.3	5.0	4.8	278	--
G92.2	6.0	5.3	22	--
G100.3	5.0	5.0	219	--
G102.2	5.4	4.9	80	--

Table A4.--pH and electrical conductivity of soil solutions in Clark County, Wash.--Continued

Sample number		pH 1:1	pH $CaCl_2$	Electrical conductivity	Water content
G110.3		5.1	4.8	104	--
G112.2		5.5	4.9	27	--
G120.3		5.4	5.1	287	--
G122.2		5.5	4.6	16	--
G130.3		5.1	5.0	113	--
G132.2		5.8	5.1	36	--
G140.3		4.8	4.4	225	--
G142.2		5.5	4.9	30	--
G150.3		5.6	4.8	23	--
G152.2		5.6	5.0	23	--
G160.3		5.2	4.7	99	--
G162.2		5.3	4.5	35	--
G170.3		5.2	4.7	225	--
G172.2		5.7	4.9	56	--
G180.3		4.9	4.6	261	--
G182.2		5.5	4.8	50	--
G190.08	V	5.3	4.9	361	--
G190.3		4.9	4.5	224	--
G190.3	V	5.5	5.2	189	--
G191.0	V	5.8	5.2	102	--
G191.6	V	5.7	5.1	34	--
G192.2		5.0	4.3	440	--
G192.2	V	5.7	4.6	38	--
G200.3	A	5.1	4.7	194	--
G200.3	B	4.7	4.4	172	--
G200.3	C	5.2	4.5	181	--
G200.3	D	5.1	5.0	325	--
G200.3	V	5.0	4.7	297	--
G200.8	V	5.3	4.7	141	--
G201.8	A	6.0	5.8	23	--
G201.8	B	5.5	4.9	38	--
G201.8	C	5.8	5.2	52	--
G201.8	D	6.1	6.0	48	--
G201.8	V	6.2	5.3	42	--
G203.0	V	5.9	4.9	32	--
G205.1	V	5.7	4.6	15	--

Table A4.--pH and electrical conductivity of soil solutions in Clark County, Wash.--Continued

Sample number	pH		Electrical conductivity	Water content
	1:1	$CaCl_2$		
G210.3	4.8	4.4	237	--
G212.2	5.1	4.4	30	--
G220.3	5.1	4.9	462	--
G222.2	5.3	5.0	186	34
G230.3	5.5	5.1	184	28
G232.2	6.2	5.1	19	28
G240.3	5.5	5.1	226	28
G242.2	5.8	5.4	139	25
G250.3	5.7	5.3	252	28
G252.2	6.6	5.7	42	26
G260.3	5.4	5.0	158	21
G262.2	6.0	5.3	42	23

Table A5.--*Grain-size distribution of soil samples in Clark County, Wash.*
[All samples were sieved prior to determination to remove particles greater than 19 millimeters (mm); gravel, 2 mm to 19 mm; sand, 62 micrometers (µm) to 2 mm; silt, 4 µm to 62 µm; clay, less than 4 µm]

Sample number	Gravel (percent)	Sand (percent)	Silt (percent)	Clay (percent)
G10.3	8.5	78.5	2.3	10.7
G12.2	7	82.5	[1]10.5	--
G20.3	2.2	85.2	1.5	11.1
G22.2	2	87.2	[1]10.8	--
G30.3	0	7	56.3	36.7
G32.2	39.2	52	[1]8.8	--
G40.3	23.6	33.8	19.1	23.5
G42.2	35.9	54.9	[1]9.2	--
G50.3	2.1	52.8	9.6	35.5
G52.2	12.5	64.5	[1]23	--
G60.3	0	63.8	2.3	33.9
G62.2	0.2	98.4	0.1	1.3
G70.3	0	74.4	2.4	23.2
G72.2	0	64	4	32
G80.3 A	0	30	18.2	51.8
G80.3 B	0	39.8	15.6	44.6
G80.3 C	0	26.2	16.9	56.9
G80.3 D	0	10	22.6	67.4
G80.3 V	0	63.2	7.3	29.5
G80.8 V	0	87.6	1.3	11.1
G81.4 V	0	83.3	1.9	14.8
G82.2 A	0	16.9	26.1	57
G82.2 B	0	14.5	22.1	63.4
G82.2 C	0	13	23.1	63.9
G82.2 D	0	7.7	27	65.3
G82.2 V	0	8.5	26	65.5
G83.0 V	0	13.2	29.9	56.9
G90.3	0	24.5	33.1	42.4
G92.2	0	91.8	2.1	6.1
G100.3	4.2	81.2	3.9	10.7
G102.2	8.3	83.2	3.8	4.7
G110.3	9	75.5	4.3	11.2
G112.2	0.5	90.8	3.9	4.8
G120.3	2.8	29	28.9	39.3
G122.2	0.5	28.6	31	39.9

Table A5.--Grain-size distribution of soil samples in Clark County, Wash.--Continued

Sample number		Gravel (percent)	Sand (percent)	Silt (percent)	Clay (percent)
G130.3		1.9	22.5	26.5	49.1
G132.2		1.1	25.5	30.6	42.8
G140.3		8.5	32.6	15	43.9
G142.2		2.2	44.5	17.9	35.4
G150.3		11.8	75.4	5.9	6.9
G152.2		5.6	75.7	8	10.7
G160.3		12.6	76.7	3.2	7.5
G162.2		3.8	69.9	10	16.3
G170.3		6	50.6	12.4	31
G172.2		0.7	54.8	14.3	30.2
G180.3		0	81.7	5.5	12.8
G182.2		0	56	17	27
G190.08	V	7.7	79	5.8	7.5
G190.3		8.1	72.6	7.8	11.5
G190.3	V	9.4	81.2	4.3	5.1
G191.0	V	11.2	82.7	2.9	3.2
G191.6	V	17.8	72	4.6	5.6
G192.2		2.9	63.2	15.6	18.3
G192.2	V	8.9	75	8.2	7.9
G200.3	A	0.8	42.7	17.7	38.8
G200.3	B	1.1	58.7	13.5	26.7
G200.3	C	1.8	51.9	13.2	33.1
G200.3	D	1	41.7	18.6	38.7
G200.3	V	1.6	38	19.4	41
G200.8	V	1.2	41	19.5	38.3
G201.8	A	0.3	49.8	18.1	31.8
G201.8	B	0	41.2	19.9	38.9
G201.8	C	0.3	54.4	14.9	30.4
G201.8	D	0.6	62.6	11.4	25.4
G201.8	V	0.1	44.6	18.5	36.8
G203.0	V	0	38.4	21.3	40.3
G205.1	V	0	45	18.5	36.5
G210.3		11.5	78	3.5	7
G212.2		3.5	72.9	12.1	11.5
G220.3		43.3	48.6	1.9	6.2
G221.3		42.1	48.9	2	7
G222.2		56.7	28	3.8	11.5

Table A5.--Grain-size distribution of soil samples in Clark County, Wash.--Continued

Sample number	Gravel (percent)	Sand (percent)	Silt (percent)	Clay (percent)
G230.3	40.6	49.3	2.2	7.9
G232.2	44.6	37.3	4.3	13.8
G240.3	6.8	83.2	2.3	7.7
G242.2	7.8	84.6	2.1	5.5
G250.3	21.1	68.2	2.7	8
G252.2	28.2	60.4	3.4	8
G260.3	32	47.1	7.8	13.1
G262.2	33.2	54.4	4.4	8

[1] Value shown is percent silt and clay.

Table A6.--Cation exchange capacity of selected samples at three different pH values in Clark County, Wash.
[Units are centimols of charge per kilogram]

Sample number	Cation Exchange Capacity		
	pH 4.0	pH 5.0	pH 7.0
G70.3	8	9.4	10.3
G80.3 V	13.3	13.5	15.6
G80.8 V	8.7	9	9.9
G81.4 V	8.6	9	9.2
G82.2 V	14.7	15.6	17.6
G83.0 V	14.3	13.9	17.4
G90.3	17.2	17.6	22.7
G92.2	8.8	8.9	10.9
G110.3	10.4	14.8	15.5
G112.2	8.8	8.9	10.9
G120.3	10.9	12.7	15
G140.3	9.8	11.5	13.9
G150.3	12.9	13.2	16.9
G170.3	10.3	13.4	15.1
G172.2	9.1	10.1	12.4
G180.3	11.7	14.8	18.8
G182.2	9	11	13.4
G190.3	18	22.9	24.9
G200.3 V	10.3	12.8	15.7
G200.8 V	10.5	12.3	13.3
G201.8 V	10.9	12.6	14.1
G203.0 V	17.8	19.1	21.5
G205.1 V	18.2	20.3	21
G220.3	18	22.4	26.4
G222.2	14.3	18.9	23.5
G230.3	22.2	25.6	28
G232.2	13	15.3	16.1
G240.3	15	19	20.7

APPENDIX B. -- QUALITY ASSURANCE

Duplicates of 12 soil samples were obtained from sample splits and were submitted as blind samples to the laboratories. Reference soil samples, prepared in an earlier study (Prych and others, 1995) by combining material from several samples collected from the Soos Creek Basin, were submitted to laboratories as well. Metals concentrations were determined for the duplicate and reference samples by all four analytical methods, as were particle-size distribution, CEC, carbon content, and soil-solution pH (tables B1 to B5).

The percent difference between the concentrations of a metal, particle-size distribution, CEC, carbon content, or soil-solution pH in a soil sample and its duplicate was calculated by dividing the absolute difference by the mean value for the sample pair and multiplying by 100 (tables B1 to B5). The percent differences calculated for total metals concentrations were generally small (table B1). However, the percent differences for total potassium, niobium, and thallium at site 17 were relatively larger (32.3, 83, and 40 percent, respectively). The percent differences calculated for total-recoverable metals concentrations were generally an order of magnitude larger than those calculated for total metals concentrations, yet were mostly below 16 percent (table B2).

The percent differences calculated for particle size, soil-solution pH, carbon content, and CEC were generally small, while the percent differences calculated for electrical conductivity were generally an order of magnitude larger than the other soil characteristics.

***Table B1.**--Concentrations of metals in duplicate soil samples analyzed by the total and total-recoverable methods in Clark County, Wash.*

[Concentrations are in milligrams per kilogram (mg/kg) of dry soil, except for Al, Ca, Fe, K, Mg, Na, P, and Ti, which are given in percent; dup, duplicate of preceding sample]

Sample numbers (duplicates)	Total					
	Aluminum (percent)	Calcium (percent)	Iron (percent)	Potassium (percent)	Magnesium (percent)	Sodium (percent)
G80.3V	7.2	2.3	4.6	1.5	1.2	1.7
G80.3V dup	7.3	2.3	4.6	1.5	1.2	1.7
Percent difference	1.4	0	0	0	0	0
G110.3	7.8	1.1	4.9	1.4	0.78	1.3
G110.3 dup	7.9	1.2	5.1	1.4	0.81	1.4
Percent difference	1.3	8.7	4.0	0	3.8	7.4
G172.2	7.6	0.85	4.7	1.3	0.76	1.3
G172.2 dup	7.8	0.85	4.9	1.8	0.78	1.3
Percent difference	2.6	0	4.2	32.3	2.6	0
G232.2	9.9	1.3	7.6	0.68	0.86	0.93
G232.2 dup	10.0	1.3	7.6	0.67	0.88	0.91
Percent difference	1.0	0	0	1.5	2.3	2.2
Reference sample	6.5	0.76	3.3	0.81	1.1	0.74

***Table B1.**--Concentrations of metals in duplicate soil samples analyzed by the total and total-recoverable methods in Clark County, Wash.--Continued*

Sample numbers (duplicates)	Total					
	Phosphorus (percent)	Titanium (percent)	Manganese (percent)	Barium (mg/kg)	Beryllium (mg/kg)	Cesium (mg/kg)
G80.3V	0.14	0.63	810	660	1	71
G80.3V dup	0.15	0.65	810	670	1	75
Percent difference	6.9	3.1	0	2	0	6
G110.3	0.2	0.85	1,200	770	1	67
G110.3 dup	0.2	0.97	1,200	740	1	75
Percent difference	0	13.2	0	4	0	11
G172.2	0.13	0.89	610	750	2	76
G172.2 dup	0.13	0.89	630	740	2	70
Percent difference	0	0	3	1	0	8
G232.2	0.22	1	1,500	670	2	85
G232.2 dup	0.22	1	1,500	670	2	85
Percent differemce	0	0	0	0	0	0
Reference sample	0.04	0.22	290	1,700	<1	36

Table B1.--Concentrations of metals in duplicate soil samples analyzed by the total and total-recoverable methods in Clark County, Wash.--Continued

Sample numbers (duplicates)	Total					
	Cobalt (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Gallium (mg/kg)	Lanthanum (mg/kg)	Lithium (mg/kg)
G80.3V	19	71	39	18	40	25
G80.3V dup	19	73	41	18	42	25
Percent difference	0	3	5	0	5	0
G110.3	19	64	28	20	39	28
G110.3 dup	20	71	25	22	44	27
Percent difference	5	10	11	10	12	4
G172.2	15	59	18	18	41	24
G172.2 dup	15	61	17	22	38	24
Percent difference	0	3	6	20	8	0
G232.2	30	41	34	26	42	17
G232.2 dup	32	40	34	28	43	17
Percent difference	7	3	0	7	2	0
Reference sample	34	110	34	18	19	41

***Table B1.**--Concentrations of metals in duplicate soil samples analyzed by the total and total-recoverable methods in Clark County, Wash.--Continued*

Sample numbers (duplicates)	Total					
	Niobium (mg/kg)	Neodymium (mg/kg)	Nickel (mg/kg)	Lead (mg/kg)	Scandium (mg/kg)	Strontium (mg/kg)
G80.3V	13	37	31	29	16	310
G80.3V dup	15	39	32	36	16	320
Percent difference	14	5	3	21	0	3
G110.3	16	32	27	17	14	220
G110.3 dup	17	34	28	18	14	230
Percent difference	6	6	3	5	0	4
G172.2	17	36	23	15	16	200
G172.2 dup	7	30	22	13	16	200
Percent difference	83	18	4	14	0	0
G232.2	16	44	18	15	33	200
G232.2 dup	14	45	19	13	33	190
Percent difference	13	2	5	14	0	5
Reference sample	6	16	69	15	7	110

Table B1.*--Concentrations of metals in duplicate soil samples analyzed by the total and total-recoverable methods in Clark County, Wash.--Continued*

Sample numbers (duplicates)	Total				
	Thorium (mg/kg)	Vanadium (mg/kg)	Yttrium (mg/kg)	Ytterbium (mg/kg)	Zinc (mg//kg)
G80.3V	9	140	24	3	200
G80.3V dup	11	140	25	2	190
Perceny difference	20	0	4	40	5
G110.3	12	160	15	2	130
G110.3 dup	12	170	15	2	140
Percent difference	0	6	0	0	7
G172.2	12	160	18	2	100
G172.2 dup	8	170	16	2	110
Percent difference	40	6	12	0	10
G232.2	8	220	44	4	110
G232.2 dup	8	220	45	5	110
Percent difference	0	0	2	22	0
Reference sample	10	50	11	1	48

Table B1.--Concentrations of metals in duplicate soil samples analyzed by the total and total-recoverable methods in Clark County, Wash.--Continued

Sample numbers (duplicates)	Total-recoverable				
	Arsenic (mg/kg)	Beryllium (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)
G80.3V	5.65	1.05	1.4	21.9	25.0
G80.3V dup	7.65	1.13	1.6	22.8	27.6
Percent difference	15.0	7.3	13.3	4.0	9.9
G92.2	3.65	0.82	0.54	15.1	24.5
G92.2 dup	2.6	0.38	0.61	12.4	19.7
Percent difference	33.6	73.3	12.2	19.6	21.7
G112.2	3.31	1.36	0.71	25.6	15.3
G112.2 dup	3.8	1.4	0.94	23.3	14.3
Percent differemce	13.8	2.9	27.9	9.4	6.8
G140.3	3.89	1.53	0.6	19.2	22.9
G140.3 dup	4.95	1.57	1.0	21.1	56.0
Percent difference	24.0	2.6	50.0	9.4	83.9
G150.3	2.64	1.9	1.3	29.0	22.2
G150.3 dup	3.35	1.76	1.2	26.0	21.9
Percent difference	23.7	7.7	8.0	10.9	1.4
G182.2	3.14	1.52	1.1	30.5	18.2
G182.2 dup	2.9	1.49	0.96	28.9	17.9
Percent difference	8.0	2.0	13.6	5.4	1.7
G240.3	2.2	1.8	1.3	16.6	19.6
G240.3 dup	2.2	1.6	1.1	17.7	21.3
Percent difference	0	11.8	16.7	6.4	8.3
Reference sample	2.8	0.53	0.55	24.5	10.0
Reference sample dup	2.7	0.58	0.41	24.4	9.7
Percent difference	3.6	9.0	29.0	0.4	3.0

Table B1.--Concentrations of metals in duplicate soil samples analyzed by the total and total-recoverable methods in Clark County, Wash.--Continued

Sample numbers (duplicates)	Total-recoverable					
	Lead (mg/kg)	Manganese (mg/kg)	Nickel (mg/kg)	Zinc (mg/kg)	Aluminum (percent)	Iron (percent)
G80.3V	17.8	450	20.7	138	2.10	2.61
G80.3V dup	23.2	490	19.5	168	2.24	2.78
Percent difference	26.3	9	6.0	20	6.5	6.3
G92.2	5.6	293	9.9	47.6	1.77	2.20
G92.2 dup	4.6	255	9.3	42.8	1.28	1.86
Percent difference	19.6	14	6.3	10.6	32.1	16.7
G112.2	8.0	562	16.5	64.0	3.24	3.35
G112.2 dup	3.6	827	15.1	57.2	3.04	3.41
Percent different	75.9	38	8.9	11.2	6.4	1.8
G140.3	54.0	536	12.4	79.6	2.56	3.43
G140.3 dup	24.8	529	13.4	78.1	2.54	3.92
Percent difference	74.1	1	7.8	1.9	0.8	13.3
G150.3	10.4	434	21.0	73.9	5.35	4.88
G150.3 dup	8.1	420	14.3	63.9	4.25	4.62
Percent difference	24.9	3	38.0	14.5	22.9	5.5
G182.2	11.0	1,370	19.0	89.0	4.51	3.75
G182.2 dup	7.3	1,310	19.9	86.9	4.47	3.76
Percent difference	40.4	5	4.6	2.4	0.9	0.3
G240.3	9.6	986	19.0	98.6	3.88	5.29
G240.3 dup	7.3	1,080	17.6	90.4	3.72	5.06
Percent difference	27.2	9	7.7	8.7	4.2	4.4
Reference sample	4.7	258	26.1	29.1	1.92	1.65
Reference sample dup	3.6	247	28.2	30.0	1.95	1.65
Percent difference	26.5	4.4	7.7	3.0	1.6	0

__Table B1__.--Concentrations of metals in duplicate soil samples analyzed by the total and total-recoverable methods in Clark County, Wash.--Continued

Sample numbers (duplicates)	Total-recoverable Mercury (mg/kg)
G80.3V	0.040
G80.3V dup	0.044
Percent difference	9.52
G92.2	0.019
G92.2 dup	0.012
Percent difference	45.20
G112.2	0.020
G112.2 dup	0.026
Percent difference	26.10
G140.3	0.040
G140.3 dup	0.005
Percent difference	15.00
G150.3	0.030
G150.3 dup	0.040
Percent difference	28.60
G182.2	0.027
G182.2 dup	0.027
Percent difference	0
G240.3	0.037
G240.3 dup	0.033
Percent difference	11.40
Reference sample	0.046
Reference sample dup	0.047
Percent difference	2.2

Table B2.--Particle-size distribution in duplicate soil samples in Clark County, Wash.
[Quantities in percent; dup, duplicate of preceding sample]

Sample numbers	Gravel (percent)	Sand (percent)	Silt (percent)	Clay (percent)
G140.3	8.5	32.6	15.0	43.9
G140.3 dup	7.5	33.4	14.9	44.2
Percent difference	12.5	2.4	0.7	0.7
G150.3	11.8	75.4	5.9	6.9
G150.3 dup	7.3	74.5	7.8	0.4
Percent difference	47.1	1.2	28.4	178
G182.2	0	56.0	17.0	27.0
G182.2 dup	0.010	66.5	5.5	27.9
Percent difference	200	17.1	102	3.3
G240.3	6.8	83.2	2.3	7.7
G240.3 dup	7.0	83.8	2.1	7.1
Percent difference	2.9	0.7	9.1	8.1

***Table B3.**--pH and equivalent conductance of duplicate soil solutions in Clark County, Wash.*
[dup, duplicate of preceding sample; 1:1, pH values determined using a 1:1 mixture by weight of soil and deionized water; $CaCl_2$, pH values determined after the addition of 1 milliliter, 1 molar $CaCl_2$ solution to the soil-water mixture; units for electrical conductivity are in microsiemens per centimeter]

Sample numbers	pH 1:1	pH $CaCl_2$	Electrical conductivity
G80.3V	5.6	5.1	218
G80.3V dup	5.6	5.0	123
Percent difference	0	2.0	55.7
G140.3	4.8	4.4	225
G140.3 dup	4.7	4.2	295
Percent difference	2.1	4.7	26.9
G150.3	5.6	4.8	23
G150.3 dup	5.5	4.8	93
Percent difference	1.8	0	120.7
G182.2	5.5	4.8	50
G182.2 dup	5.4	4.7	52
Percent difference	1.8	2.1	3.9
G220.3	5.1	4.9	462
G220.3 dup	5.1	5.1	379
Percent difference	0	4.0	19.7
G240.3	5.5	5.1	226
G240.3 dup	5.7	5.0	240
Percent difference	3.6	2.0	6.0

***Table B4.**--Concentrations of carbon in duplicate soil samples in Clark County, Wash.*
[dup, duplicate of preceding sample; quantities in percent]

Sample numbers	Total carbon (percent)	Organic carbon (percent)	Inorganic carbon (percent)
G80.3V	2.46	2.46	0.01
G80.3V dup	2.79	2.78	0.01
Percent difference	12.6	12.2	0
G110.3	3.12	3.10	0.02
G110.3 dup	2.94	2.92	0.02
Percent difference	5.9	6.0	0
G172.2	0.41	0.41	0.01
G172.2 dup	0.40	0.40	0.01
Percent difference	2.5	2.5	0
G232.2	3.51	3.51	0.01
G232.2 dup	3.74	3.74	0.01
Percent difference	6.3	6.3	0

Table B5.--*Cation exchange capacity of duplicate soil samples at selected pH values in Clark County, Wash.*
[Values in milliequivalents per 100 grams (meq/100g) of dry soil; dup, duplicate of preceding sample]

Sample numbers	Cation Exchange Capacity		
	pH 4.0 (meq/100g)	pH 5.0 (meq/100g)	pH 7.0 (meq/100g)
G80.3V	13.3	13.5	15.6
G80.3V dup	13.4	14.4	16.3
Percent difference	0.7	6.5	4.4
G90.3	17.2	17.6	22.7
G90.3 dup	16.6	18.4	20.3
Percent difference	3.6	4.4	11.2
G150.3	12.9	13.2	16.9
G150.3 dup	14.2	15.2	18.2
Percent difference	9.6	14.1	7.4

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